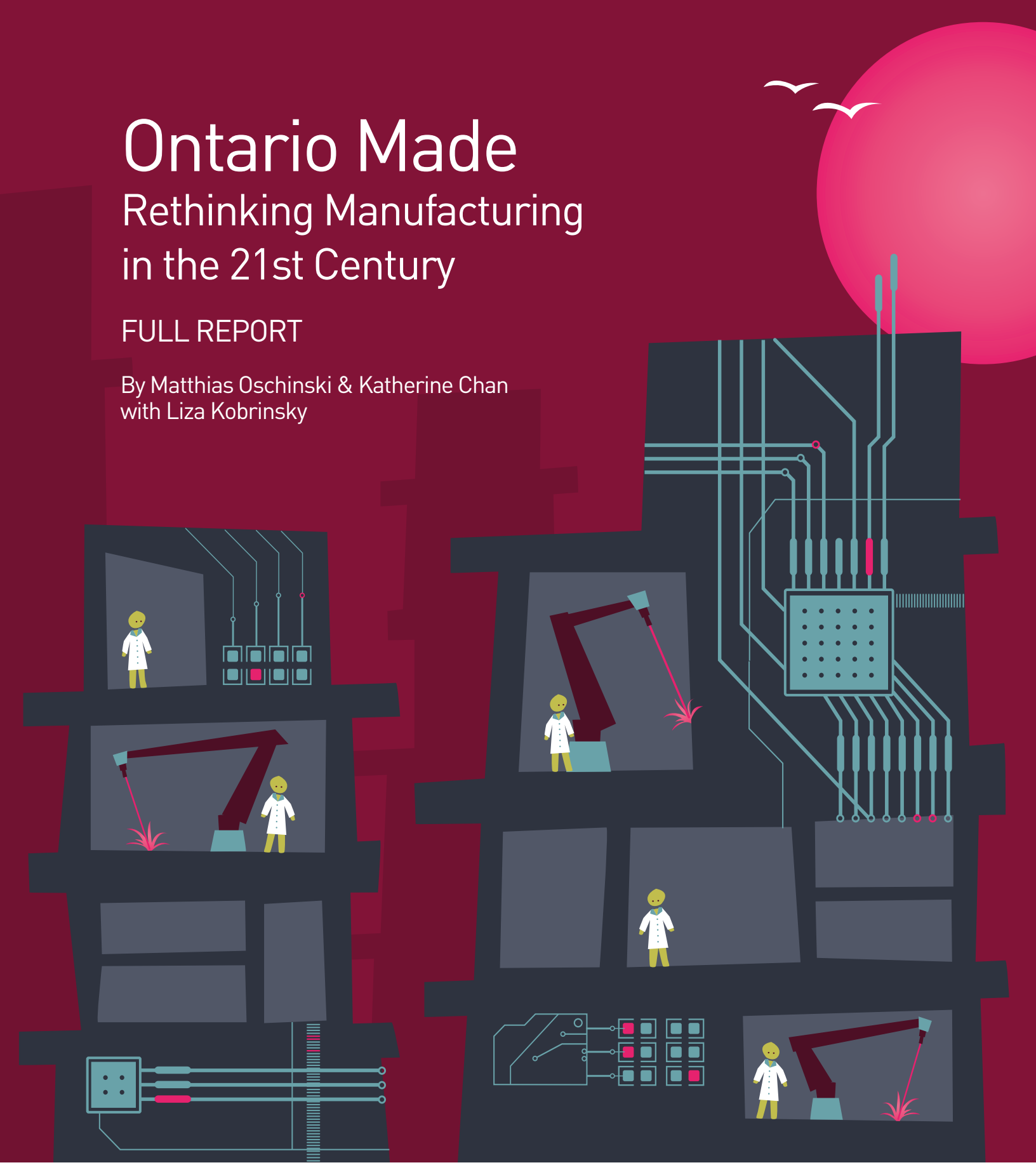
Ontario Made

Rethinking Manufacturing in the 21st Century

FULL REPORT

By Matthias Oschinski & Katherine Chan
with Liza Kobrinsky



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During his time in academia he focused mainly on global macroeconomics and international development. As a faculty member at Johannes Gutenberg-University and the University of Applied Sciences in Mainz, Germany, he taught courses in macroeconomics, microeconomics, globalization, international trade, and environmental economics. From 2009 to 2010 he participated in a study on the reduction of greenhouse gas emissions in maritime shipping for the German federal government.

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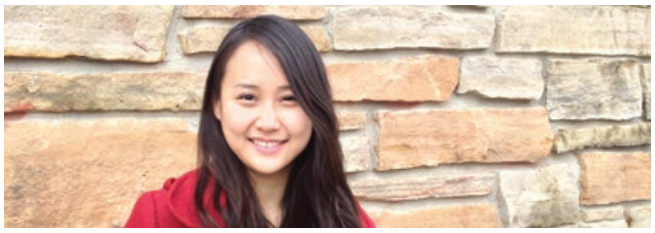

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This report envisions Ontario's manufacturing sector as one with the potential to excel in high technology, high value-added exports which would foster a highly productive, highly skilled and well-paid work force.

1

Introduction

Over the past decade, manufacturing in Ontario has been challenged by fundamental changes in the global economy. First, the rise of emerging markets has led to more competition especially with respect to low cost industries such as textiles. Second, increasing global trade resulted in the split of the value added chain in goods production. Where entire products used to be made in one location and subsequently traded in exchange for other goods, the new reality focuses on tasks along the value chain based on a country's comparative advantage. Third, ongoing structural and technological changes lead to different requirements in talent and skills. Fourth, the rise in the value of the Canadian dollar eroded Ontario's cost advantages and drove down its exports. Finally, the economic crisis in the United States, Ontario's single most important export market, contributed to a sharp drop in demand for its manufacturing.[1]

In the context of these challenges, the debate on whether manufacturing is still needed in advanced economies has divided economists in recent years. While some claim that manufacturing in developed countries is simply doomed and those concerned with the sector suffer from a "manufacturing fetish", others point to manufacturing as an essential source of innovation and job creation.[2]

This report aligns with the second point of view and argues that manufacturing is a key driver of economic growth and prosperity. Through its contribution to research and development (R&D), manufacturing is an important source of innovation. In addition, manufacturing has important linkages to other sectors in the economy. For instance, the Centre for Spatial Economics calculated that a $1 billion increase in manufacturing exports would generate an additional $805 million in manufacturing GDP and create 7,779 new jobs in the sector.

Given manufacturing's linkages to other sectors, it would also generate an additional $1.01 billion increase in GDP and raise employment by 8,776 in all other sectors combined. Moreover, manufacturing is a crucial source of export revenues. In Ontario, four of the top five international exports in 2011 were from the manufacturing sector. Finally, as manufacturing generally has higher levels productivity, wages in the sector are comparatively high as well. In Ontario, total hourly labor compensation in manufacturing has traditionally been higher than the average labor compensation of all other sectors. This, in turn, creates important fiscal benefits.

Within the new global framework, manufacturing itself is undergoing fundamental changes. New technologies and the Internet have facilitated new production processes, such as additive manufacturing, including 3D printing and cold spraying, digital manufacturing technologies, nano-manufacturing, bio-manufacturing and industrial robotics. These developments open up exciting opportunities for entrepreneurs and will change the manufacturing landscape over the medium term. In fact, many experts expect a new industrial revolution as a result of these technological changes. The impact of these advancements will

be felt beyond manufacturing itself. As new technologies allow for more customization and decentralization, they will also influence consumer behaviour, logistics and business operations. With regard to the labour market, we will see a change in skill requirements as the production process shifts from linear, repetitive tasks to more sophisticated operations.

In principle, Ontario is well placed to take advantage of these new opportunities. Its highly trained workforce, competitive education system, well-developed infrastructure and tradition as a manufacturing powerhouse put it in an excellent position to stay at the forefront of this new industrial revolution.

Ontario's technological clusters in Ottawa, Toronto and Waterloo have the capacity to bolster the movement toward "smart" hardware manufacturing. Traditional sectors now also have the opportunity to modernize their products and processes to remain competitive. Yet, to really seize the opportunities presented by new technological innovations, stakeholders need to respond to current challenges with a policy approach that cultivates Ontario's global competitive advantage in high-technology manufacturing. This report contributes to that goal by analysing the current state of Ontario's manufacturing sector vis-à-vis international peer jurisdictions to determine areas in need of improvement from a global competitiveness perspective.

Going further, the report establishes the underlying drivers of comparative advantage in high-technology manufacturing. Our findings show that the main measures to be taken in order to strengthen high-technology manufacturing in Ontario are:

» Raising competitive pressure
» Restructuring the regulatory environment
» Breaking barriers to business through greater innovation
» Fostering talent and skills

We then outline a targeted policy response in support of Ontario's manufacturing future which builds on both Ontario's comparative advantages in manufacturing and the province's broader foundational advantages.

This report envisions Ontario's manufacturing sector as one with the potential to excel in high technology, high value-added exports which would foster a highly productive, highly skilled and well-paid work force.

Section Summary

What is the state of Ontario's manufacturing sector?

Manufacturing in Canada has been on the decline in terms of both GDP and employment since 2001. This is a worrying trend for Ontario's manufacturers, who are responsible for nearly half of all Canadian manufacturing output (46%) and jobs (44%).

The vast majority (86.6%) of Ontario manufacturers are small business with fewer than 50 employees. These and other manufacturing firms usually operate at the upper end of the value chain, while more labour intensive tasks have been outsourced to countries with lower labour costs. This new division of labour has produced a shift in the composition of labour, with an increasing number of manufactuing occupations requiring higher skill and education.

As a result of occupational shifts and other changes like the rising Canadian dollar, Ontario has been experiencing declining manufacturing employment. The largest employment reductions have occurred in firms with 500 or more employees, which accounted for nearly 63 percent of all employment losses.

Compared to peer jurisdiction in the US and Germany, Ontario exhibits the most substantial employment decreases. Between 2001-2011 Ontario experienced a 5.5% drop in manufacturing employment, while US and German peers each dropped by 4.2 and 4.0%.

In terms of output, Ontario lags even further behind—the province experienced and average annual decline of 5.1 % between 2004-2009, while output has remained relatively constant over the same period in peer jurisdictions.

Although Ontario shows similar trends in manufacturing employment as a share of total employment, the fall in manufacturing output in Ontario is more striking compared to its international peers.

2

What is the state of Ontario's manufacturing sector?

Ontario accounts for 46.1 percent of Canada's manufacturing output and nearly 44 percent of the country's total manufacturing employment. The bulk of manufacturing firms are small- and medium-sized companies. Coinciding with a stronger Canadian dollar, manufacturing's share in both GDP and employment declined between 2000 and 2011. At the same time, the sector experienced an occupational shift towards higher skilled employees. While manufacturing output started to recover in recent years, employment in the various manufacturing industries is either stagnant or declining.

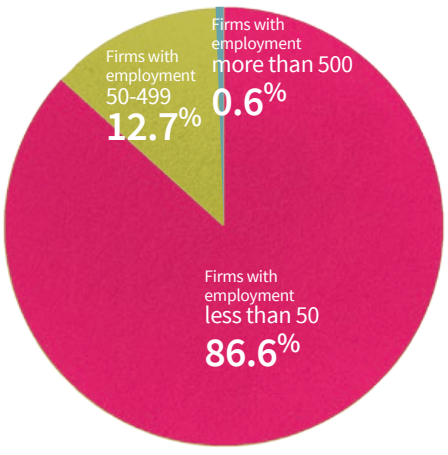
An Industry profile

With employment levels exceeding 100,000 people, a high concentration of Ontario's manufacturing can be found in the Toronto and Peel region. In Waterloo and York regions total manufacturing employment lies between 50,000 and 100,000. In the municipalities of Durham, Essex, Halton, Hamilton, Middlesex, Niagara and Simcoe between 25,000 and 50,000 people are employed in the manufacturing sector.

In Ontario, the vast majority of manufacturing firms are small-sized businesses with fewer than 50 employees (see Figure 1). Roughly 13 percent of companies are in the medium size segment, employing between 50 and 500 people. Large companies, with more than 500 employees, account for merely 0.6 percent.

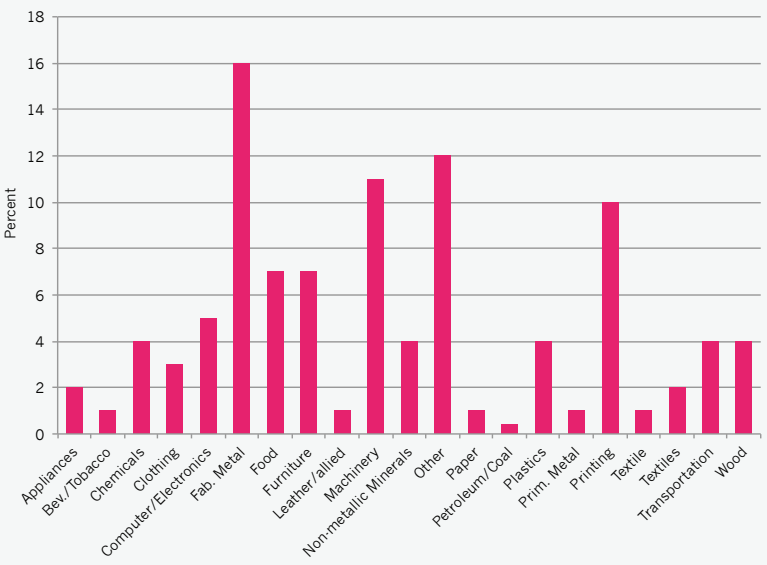
Of the 27,753 manufacturing companies recorded by Statistics Canada in 2011, the largest share (16 percent) specialized in fabricated metal, followed by miscellaneous manufacturing (12 percent) and machinery manufacturing (11 percent) (see Figure 2). The small share of firms in leather (1 percent), textiles (2 percent) and clothing (3 percent) manufacturing confirms the empirical findings about the high amount of outsourcing in these industries. With a number of labour intensive tasks outsourced to countries with relatively lower labour cost, tasks remaining in Canada are usually at the upper end of the value chain.

FIGURE 1
Number of Manufacturing Firms by Employment Size, Ontario 2011



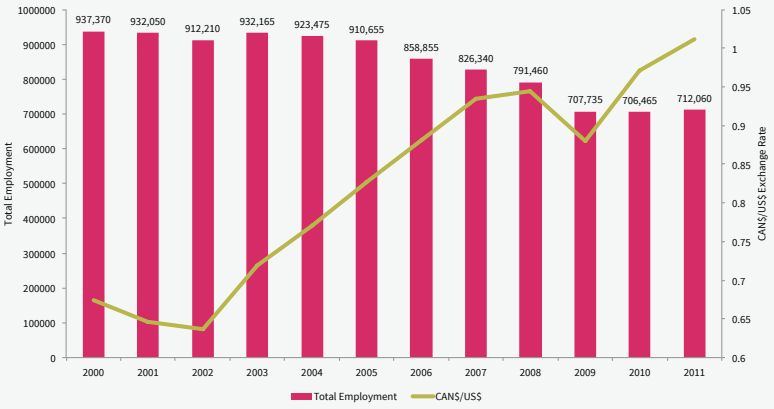
Source: Statistics Canada, Business Patterns Report.

FIGURE 2
Share of firms by type of manufacturing in Ontario, 2011



Source: Statistics Canada, Business Patterns Report.

FIGURE 3
Ontario Manufacturing Employment and CAD-USD Exchange Rate, 2000-2011



Source: Statistics Canada, CANSIM Table 383-0010.

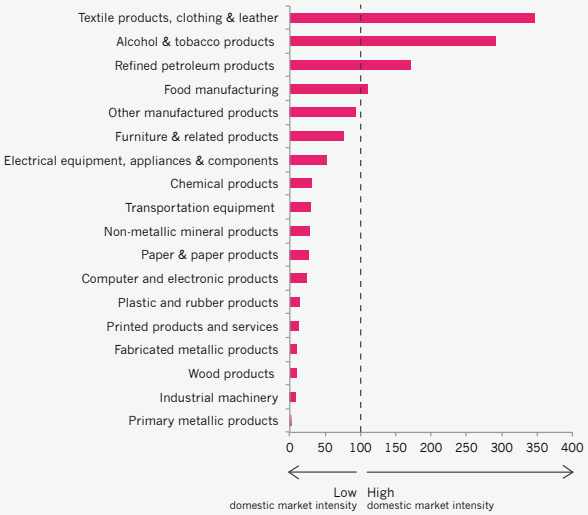
Recent developments in output and employment

As mentioned above, during the past decade the sector as a whole went through a difficult period. Employment started to decline in the early 2000s, from a total of 937,400 in 2000 to around 712,100 in 2011. Manufacturing's share of total employment dropped from 15.8 percent in 2000 to 10.3 percent in 2011. At the same time, manufacturing's share of Ontario's GDP declined from around 23 percent in 2000 to about 15 percent in 2011. As Figure 3 illustrates, falling manufacturing employment coincided with a sharp appreciation of the Canadian dollar, borne out of the global resources boom in the early 2000s, which increased demand for Canada's primary products and contributed to a surging CAD-USD exchange rate.

In addition, the Great Recession and its subsequent impact on the U.S. economy and the Eurozone increased the attractiveness of Canada as a safe haven for international investors. As a consequence, demand for Canadian dollar rose further, adding to the pressure on the CAD-USD exchange rate. With its large export share, manufacturing was negatively affected by this development. Given its near 50 percent share of Canadian manufacturing output, this was especially bad news for Ontario.

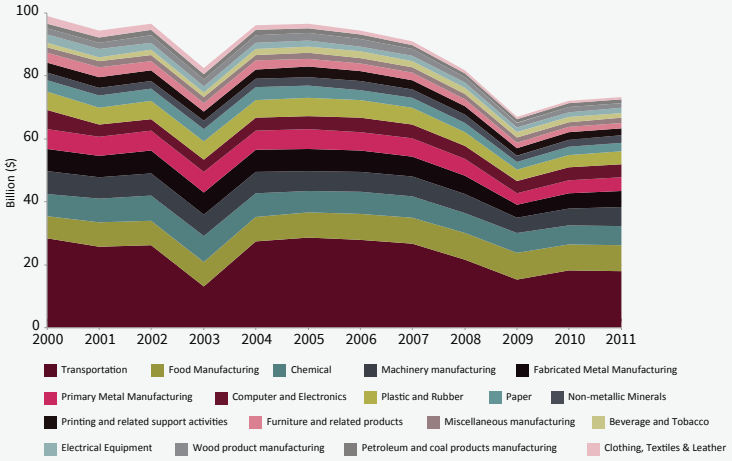
Some manufacturing industries are more affected by exchange rate fluctuations than others—manufacturing goods with a high export intensity suffer more from a high Canadian dollar compared to products mostly sold in Ontario. Applying data on

FIGURE 4
Ratio of domestic demand to export demand in Ontario manufacturing



Note: Domestic consumption is equivalent to private consumption in Ontario in 2009. Export demand is equivalent to the sum of international exports, inter-provincial exports and international re-exports.
Source: Statistics Canada, CANSIM table 381-0029

FIGURE 5
Ontario Manufacturing Production by Industry, 2001-2011



Source: Statistics Canada, CANSIM Table 379-0025

final demand from Ontario's input-output table, it is possible to calculate export intensities for the various manufacturing sub-sectors and determine those which are most vulnerable to the risks posed by a high Canadian dollar.

Figure 4 illustrates these variations, by looking at the ratios of domestic demand to export demand for various Ontario-manufactured commodities. Take, for example, the textiles, clothing and leather industry. The ratio of products sold at home to products sold outside the province results in a value of 350 in Figure 4.3 In other words, for every 100 units of textiles, clothing and leather products exported, 350 units are sold in Ontario itself. The textiles, clothing and leather industry therefore displays a high domestic market intensity (i.e. it is dependent on the domestic market more so than other industries).

Food manufacturing, to use another example, is less dependent on domestic demand. Here, for 100 units exported, 110 units are sold at home.

Overall, industries below the 100 unit threshold show a higher export intensity as foreign (or inter-provincial) demand in these cases always outweighs domestic demand. In Ontario, primary metal products carry the lowest domestic market intensity, with a mere 0.3 units sold in the province for every 100 units exported.

Additionally, Spiro (2013) points out that most of Ontario's manufacturing exports consist of standardized commodities that are more sensitive to changes in price than more specialized products. As a consequence, these industries are also more vulnerable to exchange-rate fluctuations.

Figure 5 shows manufacturing output for Ontario's various manufacturing industries. While illustrating the contraction the sector experienced until 2009, it also demonstrates that production in some industries picked up again between 2009 and 2011. These included electrical and electronic products (11 percent), transportation equipment (9 percent) and primary metal manufacturing (9 percent), all of which experienced a faster recovery in production activity. In fact, only in three of the eleven manufacturing industries, i.e. food beverage and tobacco, chemical and petroleum products, and paper products and printing, did output continue to decline after 2009.

Increasing production since 2009 did not, however, automatically translate into higher employment. As shown in Figure 6, between 2000 and 2008, employment has been on the decline in all manufacturing industries, with the highest losses recorded in transportation equipment manufacturing, primary metals, fabricated metals, clothing manufacturing and plastics and rubber products manufacturing. With the onset of the Great Recession, the decline in employment

in most sectors continued. Only three sub-industries, namely beverage and tobacco products, petroleum and coal products and leather and allied product manufacturing saw employment rising between 2009 and 2012. Overall, however, employment levels have stayed well below early 2000's-levels.

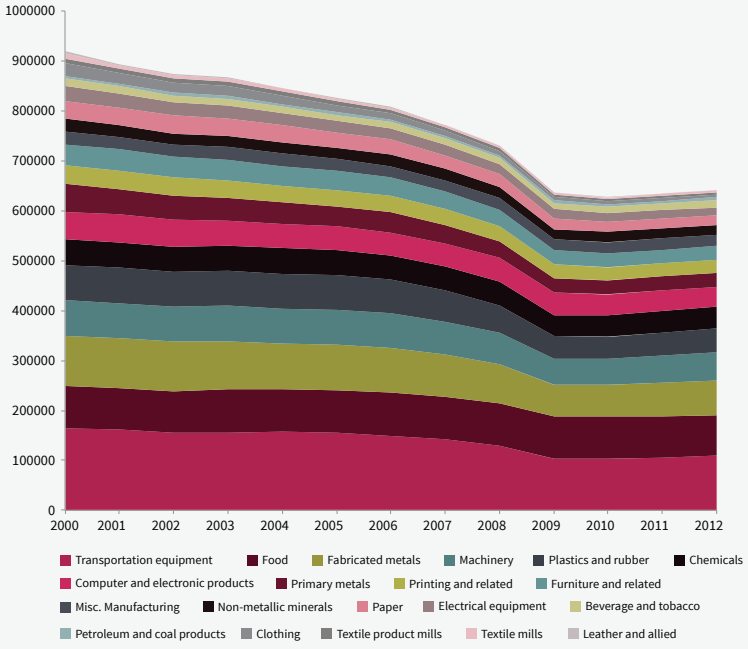
Looking at employment loss by enterprise size (Figure 7) shows that the largest reductions in percentage terms occurred in firms with 500 or more employees. These firms accounted for nearly 63 percent of all employment losses, while companies with 100 to 299 employees accounted for 14.7 percent. The lowest reduction in employment occurred in enterprises with 0 to 4 employees (about 0.5 percent of total losses) and in companies with 300 to 499 employees with a share of 4.4 percent.

Ontario is not the only region to experience declines in its manufacturing employment. Compared to its peer jurisdictions in the United States (California, Florida, Georgia, Illinois, Indiana, Massachusetts, Michigan, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Texas, and Virginia) and Germany (include Baden-Württemberg, Bayern, Hessen and Nordrhein-Westfalen), Ontario shows similar trends in manufacturing employment as a share of total employment. These jurisdictions were selected based on their similarities with Ontario's size, resource endowment and economic mix and represents a more robust comparison than country-level data.[4]

Figure 8 illustrates manufacturing employment as a share of total employment in Ontario and in German and US peer jurisdictions (in aggregate averages). While all three show a decline in manufacturing employment, the most substantial decrease is exhibited in Ontario. Over the 2000-2011 period, Ontario experienced a 5.5 percentage point drop in manufacturing employment, with the greatest fall occurring between 2004 and 2009. This drop in employment share is sharper in comparison to US and German peer jurisdictions, which fell by 4.2 and 4.0 percentage points respectively.

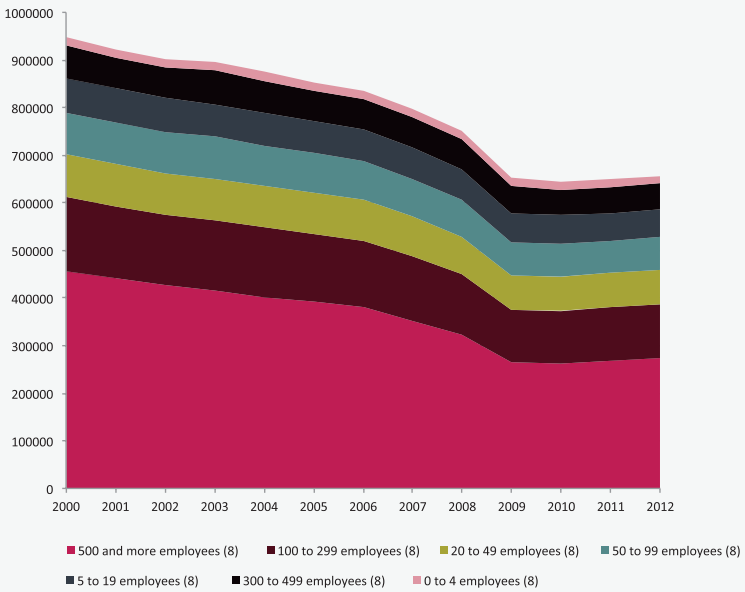
Ontario is lagging even further behind its peers in terms of output (see Figure 9). Although total manufacturing output levels, measured as total real value added, appear relatively constant in peer states, Ontario saw a precipitous decline, with an average annual decline of 5.1 percent between the

FIGURE 6
Ontario Employment by Industry, 2001-2012



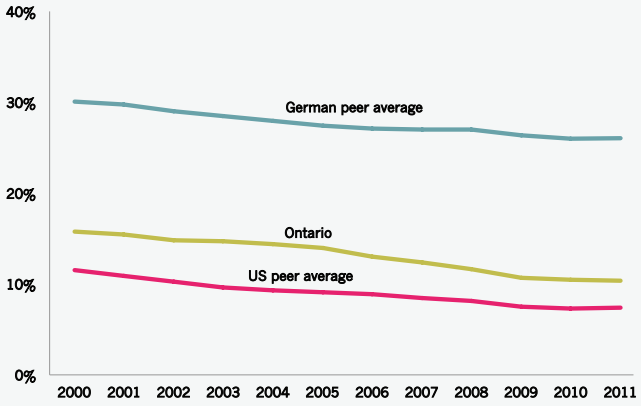
Source: Statistics Canada, CANSIM Table 281-0024.

FIGURE 7
Employment in Ontario Manufacturing by Enterprise Size, 2000-2012



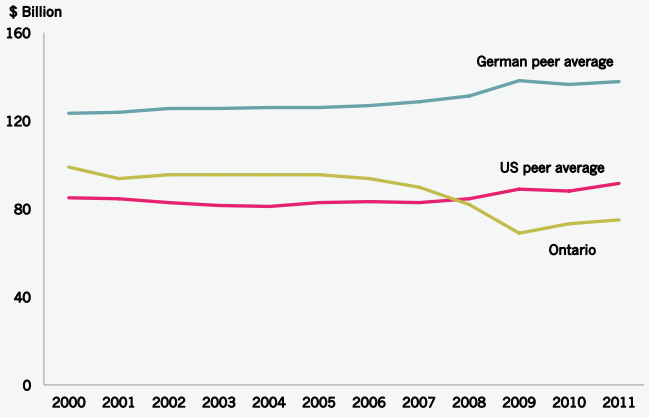
Source: Statistics Canada, CANSIM Table 281-0041

FIGURE 8
Manufacturing employment as a share of total employment, 2000-2011



Source: Statistisches Bundesamt, 2013; OECD; Statistics Canada CANSIM Table 383-0010; and U.S. Bureau of Economic Analysis.

FIGURE 9
Real manufacturing value added in Ontario versus peer jurisdictions, 2000-2011



Source: Statistisches Bundesamt, 2013; OECD; Statistics Canada CANSIM Table 379-0025; and US Bureau of Economic Analysis.

2004 to 2009 period. The decline can be partly be explained by the negative effects of the rising Canadian dollar, which significantly impacted a number of manufacturing industries.

Since 2009 however, this descent has stabilized in Ontario. It is noted too that despite pronounced declines in employment in manufacturing-intensive U.S. peer states such as Indiana, Ohio and Michigan, real manufacturing output in these jurisdictions remained fairly constant during this ten-year period.[5]

Additional explanations for the employment decline

Some authors hesitate to single out the strong Canadian dollar as the sole source of Ontario's dismal performance in manufacturing over the past decade.[6] Additional explanations take into account demographic developments and productivity differentials.

Like most developed countries, Canada is facing the challenges of an ageing population. This demographic trend gives rise to a change in consumer demands. In other words, demand for health care and related social services rises. This increases the need for employment in these service industries. As a consequence, employment shifts from the manufacturing sector towards the services sector.

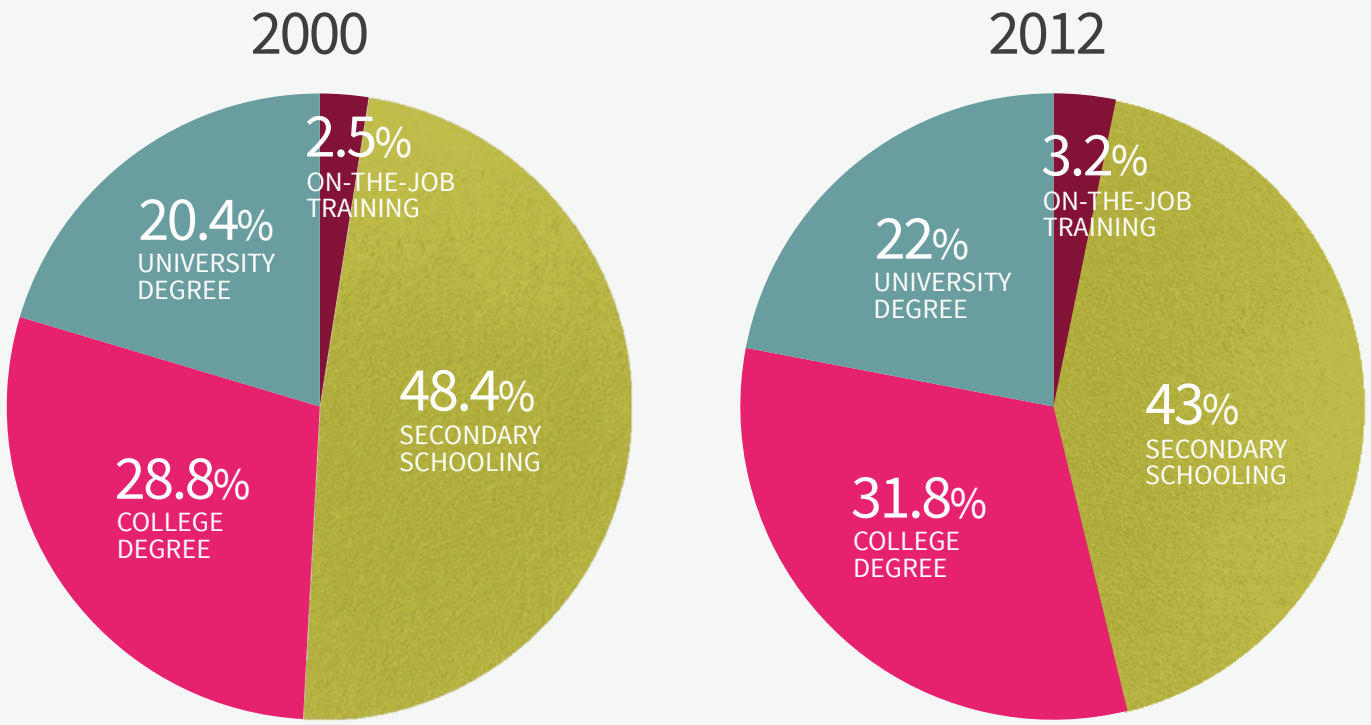
The rationale behind productivity differentials also provides a compelling explanation for the decline in manufacturing employment. The rationale asserts that where manufacturing productivity growth is consistently higher, as in the case of most OECD countries, companies are able to produce the same amount of output with fewer employees. This in turn contributes to a reduction in overall employment.

Occupational shifts

The employment landscape in the manufacturing sector has been in a state of flux since the beginning of the 2000s: by 2008, Ontario had already lost almost one in five manufacturing jobs, with the subsequent years of the Great Recession further aggravating the situation. During the same period, the sector also underwent a shift in the composition of labour, toward an increase in positions requiring higher skill and education.

Figure 10 illustrates the change in skill requirements in the manufacturing sector over the past decade, using the categories employed in the national occupational matrix. As the numbers indicate, between 2000 and 2012, the share of occupations requiring university education rose from around 20.4 percent to 22 percent.

FIGURE 10
Employment shares by skill requirement



Source: Statistics Canada, Labour Force Survey

Similarly, the share of occupations requiring college education or apprenticeship training increased from 28.8 percent to 31.8 percent in the same period. In contrast, the share of occupations requiring secondary schooling and/or occupation-specific training, such as machine operators and assemblers, declined markedly from 48.4 percent to 43 percent. Going against the general trend toward more high-skilled occupations, the employment share of the lowest skill category, occupations requiring on-the-job training, did increase slightly from 2.5 percent in 2000 to 3.2 percent in 2012.

Overall, these figures indicate somewhat of a shift in the tasks performed in manufacturing in Ontario, in line with empirical findings of the new division of labour along the global value chain. While tasks at the lower end of the value chain, such as assembly and production, are largely being performed in countries with relatively lower labour cost, developed countries focus more on tasks like research and development, design or marketing and branding.

Section Summary

How has manufacturing been affected by the new global economy?

» Two key factors have led to the fundamental changes affecting manufacturing in industrialized countries; lower tariff barriers and a significant reduction in transportation cost, both resulting from liberalization of developing markets.

» These changes have been followed by a more refined division of labour, where trade in finished goods has given way to trade in tasks and countries now specialize in specific value chain tasks according to their comparative advantage.

» Canadian textile and clothing manufacturing experienced some of the biggest labour losses as a result of these shifts. Between 2004-2008 alone, half of the industry's workforce was lost.

» Another possible explanation for overall manufacturing decline in Canada is the development of 'Dutch Disease'—a phenomenon observed in some resource-rich countries, where an increase in global demand drives up prices of natural resources. As a result, employment shifts from tradable industries (manufacturing) to the expanding resource sector and the non-tradable services sector. Subsequent manufacturing decline can then lead to decreasing productivity and innovation.

Two developments had a major impact on the manufacturing sector in recent years. First, trade in goods largely gave way to trade in tasks. Second, a higher demand for natural resources increased demand for Canada's mining and oil products.

3

How has manufacturing been affected by the new global economy?

Two key developments have exerted major impacts on the manufacturing sector in recent years. First, trade in goods has largely given way to trade in tasks. As a result, countries have come to specialize in different tasks along the value chain in the production of specific commodities. For Canada and Ontario, this has led to a shift in the demand of labour in manufacturing from relatively lower skilled workers to relatively higher skilled workers.

Second, a higher demand for natural resources has increased demand for Canada's mining and oil products. This in turn contributed to a rise in the value of the Canadian dollar, hampering the competitiveness of Ontario's manufacturing industries. In this context, research suggests that Ontario needs to reinforce efforts towards innovation and productivity to strengthen its manufacturing sector.

The rise of global value chains

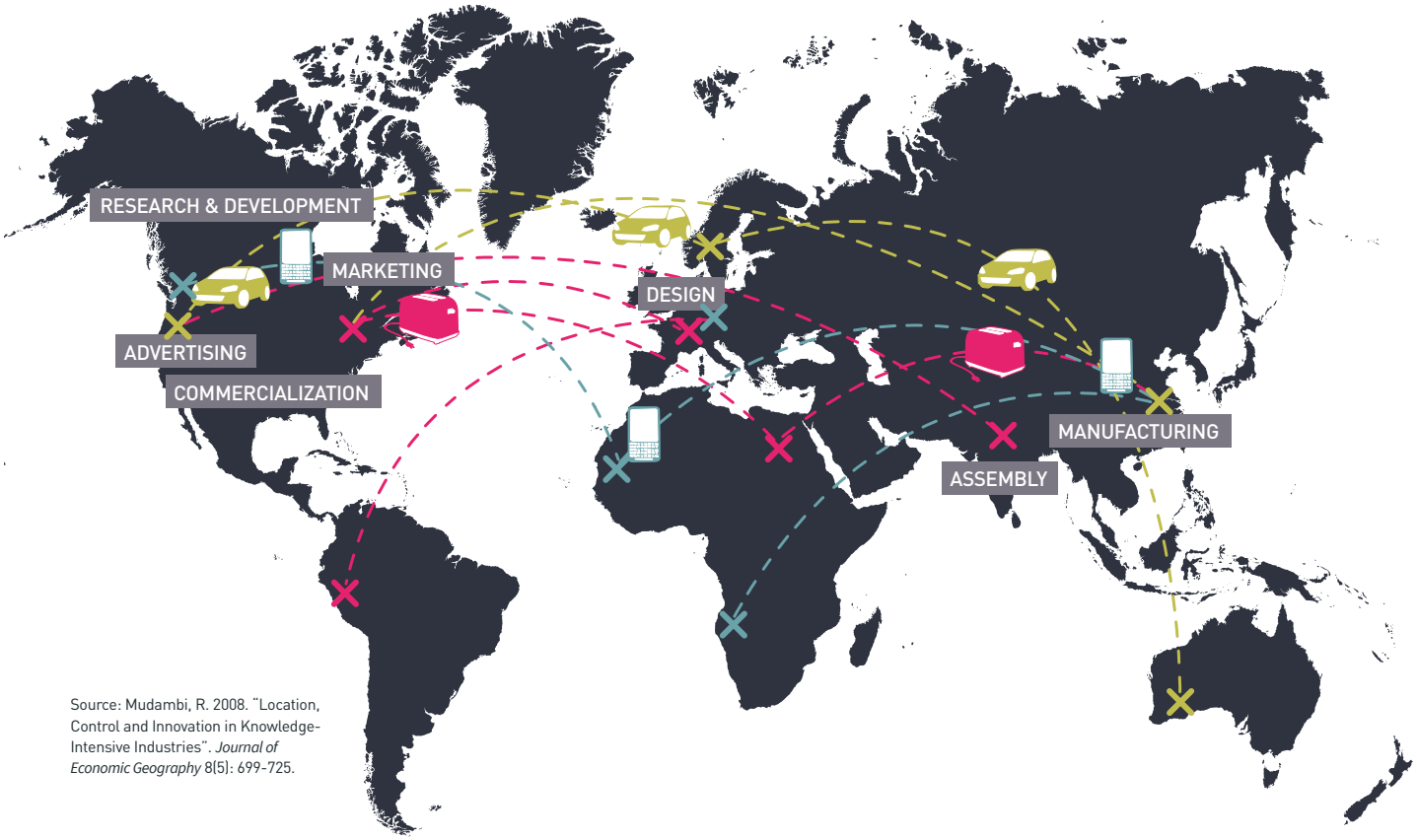
Canadian manufacturers have faced increasing challenges over the past 15 years. During the latter part of the 1990s, manufacturing in Canada experienced a boom with employment growth in the sector exceeding that of the overall economy. After peaking in 1999, employment in manufacturing stagnated for several years and started to decline from 2004 onwards. In fact, between 2004 and 2008 almost one in seven jobs were shed in manufacturing. Given its large share of manufacturing employment in Canada, Ontario was the hardest hit province in terms of manufacturing job losses.[7]

Two decisive factors have contributed to the fundamental changes affecting manufacturing sectors in industrialized countries; lower tariff barriers and a significant reduction in transportation cost. Moreover, in the past three decades, declining transportation costs and tariff reductions through multilateral and bilateral trade agreements were accompanied by economic liberalization in a number of developing countries and emerging markets. This created opportunities for companies to outsource jobs and seek the lowest cost alternatives on a global scale.[8]

These developments gave rise to a more refined division of labour. More specifically, trade in finished products gave way to trade in tasks. Thus, instead of producing a consumer good in one place and then trading it, countries increasingly started to specialize in specific value chain tasks, according to their respective comparative advantage.

For newly industrializing countries with an abundance of relatively cheap labour, the comparative advantage usually lies in standardized tasks with a high labour component. In this context, it is not surprising that the Canadian textile and clothing manufacturing experienced some of the biggest labour losses of the past decade—roughly half of its workforce was lost between 2004-2008 alone.

FIGURE 11
The Global Value Chain



Source: Mudambi, R. 2008. "Location, Control and Innovation in Knowledge-Intensive Industries". *Journal of Economic Geography* 8(5): 699-725.

With a relatively well-educated workforce and higher endowment in capital, developed economies commonly have a comparative advantage in tasks at the higher end of the value chain, such as Research and Development (R&D), design and marketing. Figure 11 depicts the contours of this global value chain.[9]

In Canada, the introduction of the North American Free Trade Agreement (NAFTA) added to the trade effects on manufacturing. Between 1994 and 2001 the composition within the manufacturing sector changed in favour of an expansion in durable goods, such as auto and machinery production whereas the share of non-durable manufactures declined. With regard to labour, demand continued to shift from a lower skilled workforce to more highly educated employees, reflecting the specialization along the value added chain.[10]

Just Dutch disease or lack of productivity?

An additional challenge for Canadian manufacturing productivity has been the strong rise of the Canadian dollar in recent years.[11] In fact, the favourable exchange rate during the late 1990s gave manufacturers a price advantage over U.S. products making Canadian commodities more competitive.

Things changed, however, in the early 2000s as the resource boom drove up prices of primary goods, creating ripple effects throughout the Canadian economy. Rich in natural resources, Canada's mining and oil sectors profited from increased global demand for primary commodities, which eventually resulted in an appreciation of the Canadian exchange rate. The new strength of the Canadian dollar, however, drove up Canadian manufactures' prices, decreasing the sector's international competitiveness in the process.

The surging exchange rate, driven by the resource boom, has incited controversy over a potential 'Dutch Disease' developing in Canada that could lead to negative long-term prosperity effects.[12] A phenomenon frequently observed in resource-rich countries, Dutch Disease can occur when an increase in global demand drives up prices of natural resources. As a result, employment in the resource-rich country shifts from other tradable industries, e.g. manufacturing, to the expanding resource sector and the non-tradable services sector, e.g. retail or the accommodation and food industry. The subsequent decline of the manufacturing sector can then lead to decreasing productivity and innovation, harming long-run growth potentials.[13]

Research shows that industries most influenced by Dutch Disease are those that tend to be more labour intensive with little product differentiation in the market. Notably, Canada's larger manufacturing industries, such as the automotive sector, appear to be only minimally affected by Dutch Disease effects.

The most resilient industry in Ontario appears to be food, beverage and tobacco manufacturing with little display of labour shedding or reduction in output during the recession.

4

Productivity

Manufacturing is changing in tandem with the Ontario economy. New technologies driven by the Internet and 3D printing are creating new and exciting possibilities for our advanced economy. Important success factors to reaping the benefits of these new opportunities are productivity, the ability of companies to scale up production, and the potential for sustainable growth.

This section takes an in-depth look at how Ontario's manufacturing sector currently performs on these elements of success. To properly evaluate Ontario's performance, we compare it to international peer jurisdictions in the U.S. and Germany.

With regard to productivity, the analysis focuses on labour productivity measured as real GDP per hours worked. In this context, a closer look at three input factors to production—labour, capital and energy—reveals Ontario's current international competitiveness and areas in need of improvement.

Since purely focusing on productivity is too limited to assess a given firm's success, this section includes an additional important piece of analysis: a firm's ability to scale up production. To this end, we evaluate high growth firms, survival rates and bankruptcy rates and analyze access to financing.

Finally, the section also provides a closer look at the possibilities for sustainable growth, that is, the maximum growth rate a firm can sustain without having to borrow more money. Companies growing too quickly run the risk of surpassing their sustainable growth rate and having to change their financial strategy—either by taking on more debt or investing more equity capital—in order to facilitate more growth. The main drivers for continued growth are talent and skills, the potential for innovation and access to export markets.

In terms of the methodology employed in this section, the manufacturing sector was decomposed into three sections, comprising High, Medium and Low Productivity sub-industries to allow for an analysis at the sub-industry level,. These categories were calculated and ranked based on overall productivity levels in all manufacturing sub-industries among international jurisdictions.

The rationale behind creating this classification of sub-industries is to gain a greater understanding of the distinctive characteristics of the various manufacturing industries. Looking purely at the combined manufacturing sector can mask important differences between these industries.

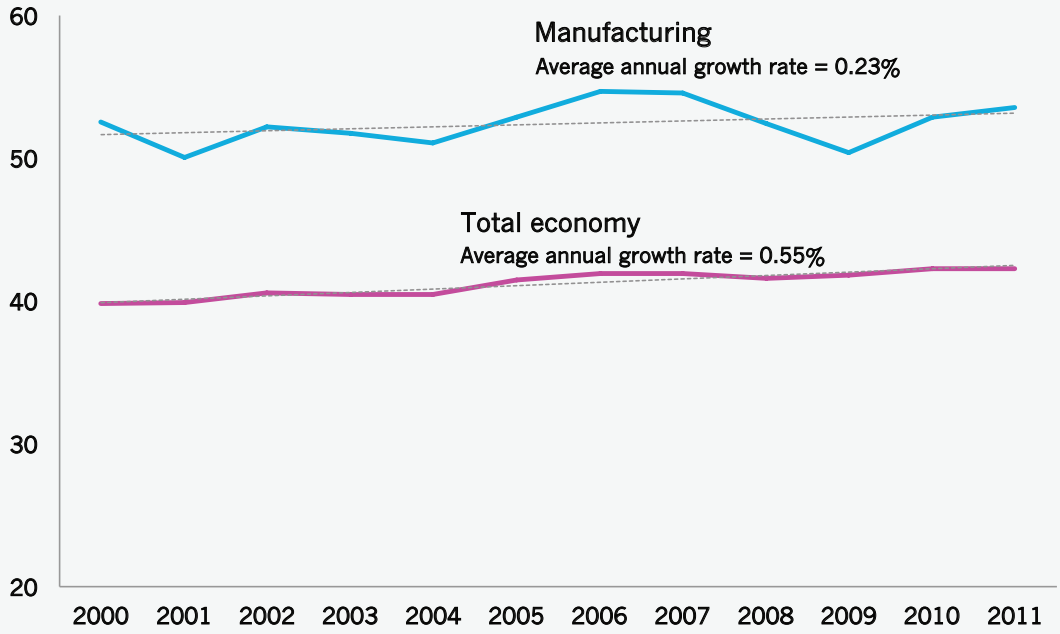
FIGURE 12
Industry sub-sectors by Productivity Groups

HIGH PRODUCTIVITY	MEDIUM PRODUCTIVITY	LOW PRODUCTIVITY
Chemical products	Electrical equipment, appliances & components	Apparel and leather and allied products
Computer and electronic products	Machinery	Fabricated metal products
Food, beverage and tobacco products	Miscellaneous manufacturing	Furniture and related products
Petroleum and coal products	Non-metallic mineral products	Printing and related support activities
Primary metals	Paper products	Textile mills and textile product mills
Transportation Equipment	Plastics and rubber products	Wood products

The group of High Productivity industries, for instance, share similar traits of higher value added good production and more capital-intensive production processes. These industries possess a greater proportion of jobs that are positioned at the upper end of the global value chain. Furthermore, these firms also have a greater intensity in the non-production worker to production worker ratio (see Talent and Skills section for more detail). Combined, these factors are indicative of higher skill and education levels, more R&D expenditure and more innovative practices within these industries.

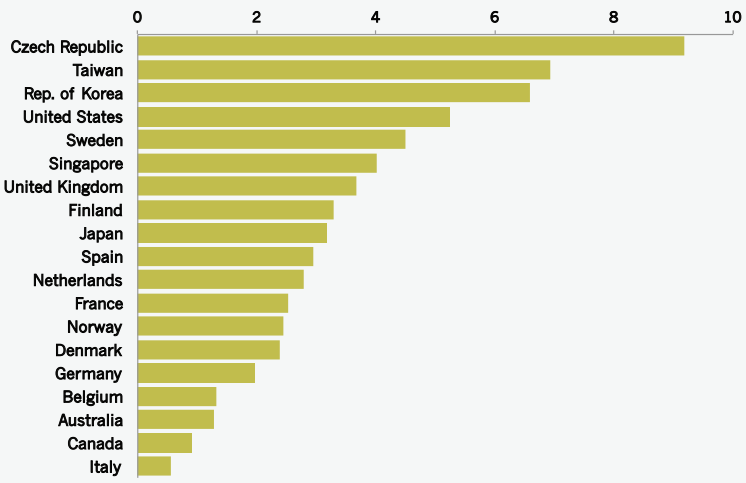
In contrast, the Low Productivity group includes industries producing lower value-added goods such as textiles, wood and clothing manufacturing. Figure 12 displays the groupings of High-, Medium- and Low Productivity sub-industries.

FIGURE 13
Manufacturing productivity showed tepid growth over the 2000 to 2010 period



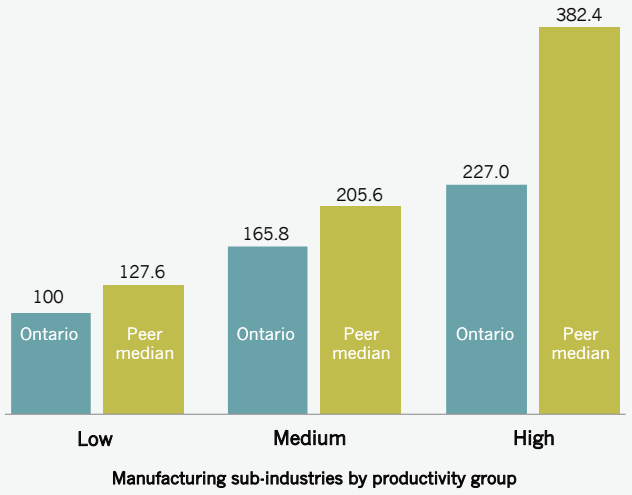
Note: This chart depicts total labour productivity.
Source: Statistics Canada, Cansim Tables 383-0022, 383-0010, 379-0025; and Labour Force Survey (LFS) microdata

FIGURE 14
Productivity growth, international comparison
2000-2011



Source: US Bureau of Labor Statistics, International Comparisons of Manufacturing Productivity and Unit Labor Cost Trends, 2011 Data Tables

FIGURE 15
Productivity levels between Ontario and North American peer jurisdictions, 2010



Note: Firms with low productivity = 100
Source: Statistics Canada, CANSIM Table 383-0022, 383-0010, 379-0025, Labour Force Survey microdata; US Bureau of Economic Analysis; and US Current Population Public Use Microdata Survey (PUMS)

A vital component to maintaining Ontario's competitiveness is higher productivity. As mentioned, our analysis specifically focuses on labour productivity. This is measured as real gross domestic product (GDP) over total hours worked. Labour productivity plays a crucial role in Ontario's broader economic prosperity and is a significant indicator of success for Ontario's manufacturing sector.

Overall, the analysis indicates that labour productivity in the manufacturing sector has remained relatively constant over the 2000 to 2010 period, with a tepid average annual growth rate of 0.23 percent (see Figure 13). In comparison, labour productivity for all industries in Ontario grew by 0.55 percent. This shows that Ontario manufacturers performed well below average over the past decade. In a national comparison however, productivity *levels* of Ontario's manufacturing sector continued to exceed Canada's overall manufacturing performance. Yet, average annual productivity *growth rates* in Ontario's manufacturing sector remain below the national average.

Compared internationally, Canada's manufacturing industry appears to be less competitive in relation to its counterparts, trailing most developed countries in average annual growth of total output per hour (Figure 14). This signals lost productivity potential and an unsustainable trend in the long run.

In order to obtain a clearer picture of productivity differentials in the various manufacturing industries, the following section gives a more detailed analysis on the subject of labour productivity.

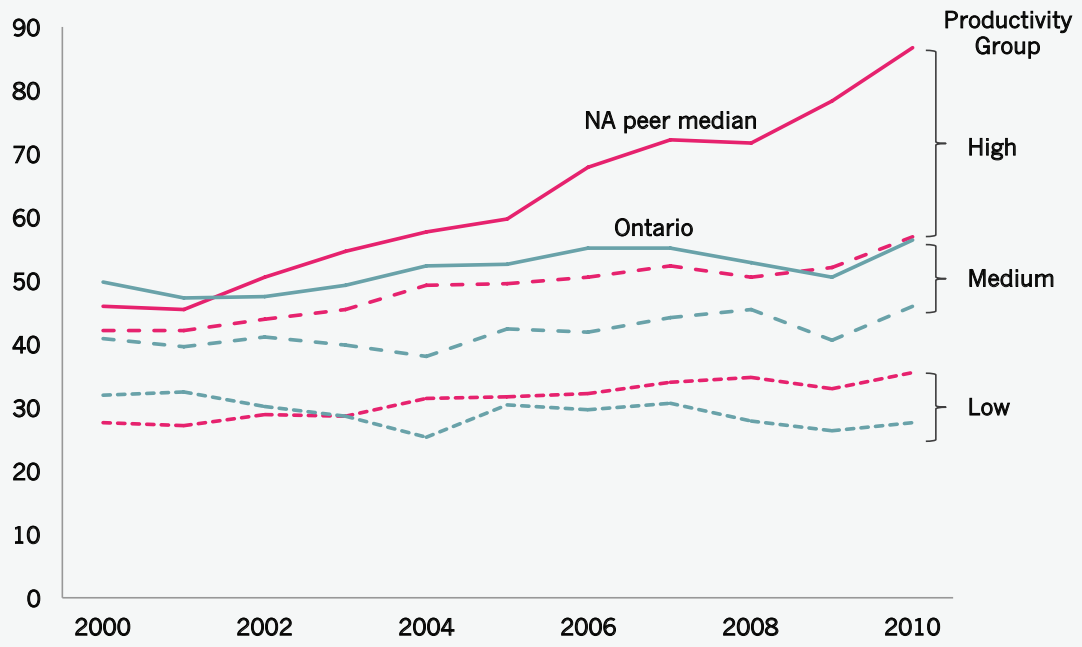
Figure 15 compares the productivity levels of Ontario firms with the median productivity levels of North American peers.[14] The comparison was facilitated by an evaluation of Ontario manufacturing sub-industries with North American peer jurisdiction equivalents. As the figure illustrates, Ontario trails its peers in all three of our manufacturing productivity sub-groups (low, medium and high), as of 2010.

More startling is the significant gap found between Ontario and its peers in the High Productivity group, with Ontario's peers performing on average over 1.6 times better than Ontario firms in the same sector.

In this High Productivity group, Ontario firms in petroleum and coal product and computer and electronic product industries appear to have the highest productivity gap relative to North American peers, operating at only 51.0 and 60.9 percent of average US peer productivity levels, respectively.

Figure 16 sheds more light on Ontario's productivity growth trajectory by measuring the productivity gap over time. It illustrates a striking trend between Ontario and its North

FIGURE 16
Productivity growth trends between Ontario and North American peer jurisdictions



Note: High Productivity Group excludes the petroleum and coal product manufacturing industry.
Source: Statistics Canada, CANSIM Table 383-0022, 383-0010, 379-0025, Labour Force Survey microdata; US Bureau of Economic Analysis; and US Current Population Public Use Microdata Survey (PUMS)

American peer jurisdictions. Most notably, the performance of Ontario's sub-industries in the High Productivity group are shown to have remained relatively constant over the 2000 to 2010 period, in stark contrast with the soaring productivity growth trend held by North American peer states.

Meanwhile, Ontario's sub-industries in the Low Productivity group performed better than the peer average in the early 2000s, but this advantage has since been eroded. Overall productivity trends among all three productivity groups show that Ontario faces a loss in future competitiveness should this trend continue.

It is important to note, however, that high productivity growth is not necessarily a perfect measure of economic success. This is because it can be driven either by an increase in output, which is generally positive from a macroeconomic perspective, or by labour shedding, a less desirable option from a social policy perspective. Therefore, in order to judge an increase in productivity properly, we need to understand what drives the effect.

In this context, a deeper exploration into individual productivity components is necessary to explain the drivers of productivity growth within each industry. For instance, non-metallic mineral product manufacturing industries exhibit the largest growth in productivity with an 8 percent average annual increase over the 2000 to 2010 period.[15] However, this increase in productivity is mainly a result of labour shedding in 2010 due to the lagged effects of the Great Recession. Accounting for this effect, average annual productivity grew at just 1.1 percent during the 2000 to 2009 period.

The analysis also reveals the behavioural responses of firms during periods of recession. These are often contingent on varying levels in capital intensity within each sub-industry. A closer examination into the High Productivity group shows that sub-industries with higher levels of capital intensity tend to lose value added (due to a fall in demand) during an economic downturn. Sub-industries with these characteristics include chemical manufacturing, computer and electronic product manufacturing as well as petroleum and coal product manufacturing.

In contrast, relatively less capital-intensive sub-industries such as primary metal and transportation equipment have a greater tendency to shed labour during a recession and as a consequence, show in an increase in productivity.

The most resilient industry in Ontario appears to be food, beverage and tobacco manufacturing with little display of labour shedding or reduction in output during the recession. One reason for this might be that food items are an essential part of people's overall consumption and are less likely to replace domestic products with imported products (especially in cases where imported products are more expensive due to trade regulation).

Given the differences between manufacturing industries, this analysis shows that, although it is important to raise overall productivity, policy should be tailored from a sectoral approach rather than embodying a one-size fits all policy to improve the overall manufacturing sector.

As mentioned, the effectiveness with which the input factors of labour, capital and energy are used is vital in determining international competitiveness and closely related to the issue of productivity. The next section takes an in-depth look at these factors, before we turn to additional elements of success.

The most significant barrier to more ICT investment are the set-up and running costs of adopting more ICT M&E. Canada is identified as the country with the highest percentage of businesses citing cost as the greatest barrier.

5

Analysing input factors and indicators of success

This section examines three broad components of production: labour, capital and energy. It sheds light on the efficiency and cost differentials between Ontario and its international peers. It further illuminates the diminishing cost advantage that Ontario manufacturers face as the sector undergoes fundamental shifts in the global economy.

Labour costs

Labour costs are a decisive factor in investment decisions made by manufacturing firms. A decade ago, differences in wage rates were a major driver in the outsourcing and offshoring of jobs to newly emerging markets. More recently, companies in Ontario face competition closer to home. The resurgence of manufacturing in the U.S. is accompanied by a discussion about Right-to-Work legislation and whether North American jurisdictions with comparatively lower labour costs are more successful in keeping or attracting manufacturing industries.

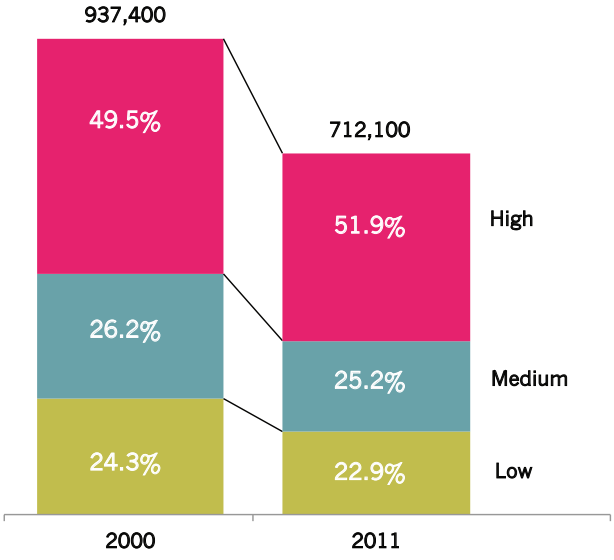
Yet, a manufacturing sector exhibiting well-paid jobs and high levels of competitiveness need not be mutually exclusive, as long as productivity grows as well. So what is the picture for Ontario?

In Ontario in 2011, as much as 51.9 percent of total manufacturing employment fell into sub-industries within the High Productivity group. Medium Productivity firms account for 25.2 percent of total manufacturing employment while the Low Productivity group contributed 22.9 percent of all jobs (see Figure 17).

Meanwhile, in 2000, as much as 24.3 percent of total manufacturing employment was found in Low Productivity firms, indicating a decline of 1.4 percentage points by 2011. As mentioned, High Productivity industries had an employment share of 49.5 percent of total manufacturing in 2000, and experienced an increase by 2.4 percentage points by 2011.

This suggests that manufacturing employment shifted from lower value added goods to higher value added products, with the biggest increases occurring in the food, beverage and tobacco industry as well as the petroleum and coal product industry.

FIGURE 17
Ontario's manufacturing employment as a share of total manufacturing employment



Source: Statistics Canada, CANSIM Table 383-0022, 383-0010, 379-002 and Labour Force Survey microdata

Overall however, Ontario's total manufacturing employment declined significantly over the past decade, shrinking by as much as 24 percent, an equivalent of 225,300 workers.

In Ontario, real labour compensation per job in total manufacturing fell by as much as 5.3 percent over the last decade, from an average of $65,000 in 2000 to about $61,500 in 2011.16 Figure 18 illustrates that labour compensation rose slightly alongside average productivity growth up until 2007.

However, the Great Recession appeared to have had a significant impact here—shown first in a reduction of labour compensation, followed by a surge in productivity. The delay in rising unemployment may be indicative of labour hoarding by manufacturing firms, reacting with cuts in labour compensation first before laying off workers.

FIGURE 18
Labour compensation per job and average productivity over time

Source: Statistics Canada, CANSIM Table 383-0010, 326-0021, 379-0025; OECD; US Bureau of Economic Analysis; and US Current Population Public Use Microdata Survey (PUMS)

Figure 19 illustrates average real labour compensation growth by High-, Medium- and Low Productivity sub-sector groups. Defined as a measurement of sub-industry effectiveness, average labour compensation growth (alongside productivity growth) is an important driver of greater sectoral and overall economic growth. Despite positive labour compensation growth in the High Productivity group, Ontario also shows lower growth vis-à-vis its US peer jurisdictions.

FIGURE 19
Average real labour compensation growth by productivity group

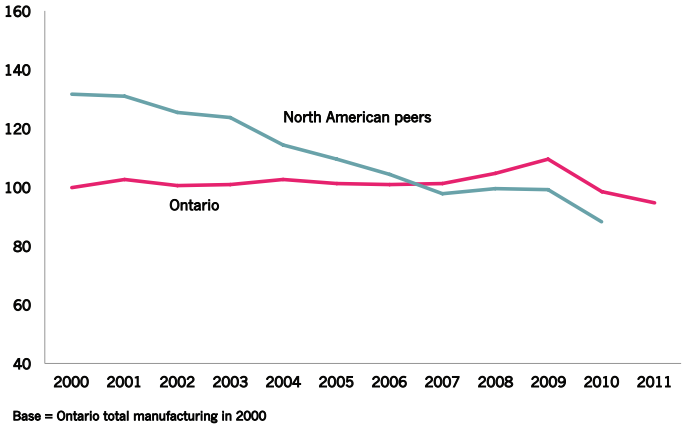
PRODUCTIVITY GROUP	ONTARIO	US PEER MEDIAN
High	0.4%	2.0%
Medium	-0.4%	1.3%
Low	-0.6%	0.1%

Note: Quebec was not included in the peer calculation. The comparison group includes only US peer jurisdictions.
Source: Statistics Canada, CANSIM Table 383-0010, 326-0021, 379-0025; OECD; US Bureau of Economic Analysis; and US Current Population Public Use Microdata Survey (PUMS)

Labour compensation sheds light on Ontario's cost effectiveness when measured as an input cost. Unit labour costs, calculated as a ratio of total labour compensation to total value added in each sub-sector, therefore, measure the cost of labour per unit of output produced.

As illustrated in Figure 20, Ontario had experienced a complete reversal of its unit labour cost advantage by 2007. While peer counterparts show a steady decline in labour cost ratios over the past decade, unit labour cost in Ontario stayed fairly constant over the past decade. In terms of labour costs, then, U.S. peers gained an advantage over Ontario after 2006.

FIGURE 20
Unit labour cost as a ratio of total output in Ontario versus North American peers

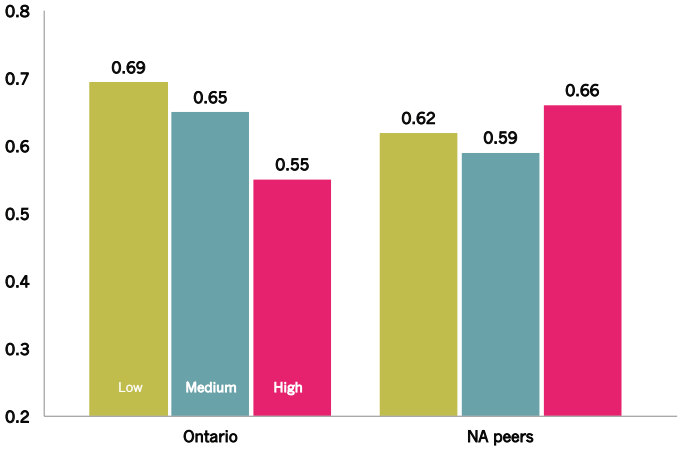


Source: Statistics Canada, CANSIM Table 383-0010, 326-0021, 379-0025; OECD; US Bureau of Economic Analysis; and US Current Population Public Use Microdata Survey (PUMS)

Figure 21 shows average unit labour costs for our different sub-sector categories. Average unit labour costs for Low- and Medium Productivity groups are lower in North American peers relative to Ontario firms. Low unit labour ratios signify lower labour cost with respect to total output in these sub-industries. An explanation for this result may be that Ontario's companies practiced greater labour hoarding (a practice of retaining workers in spite of a recession) compared to its US peers after the 2007 economic downturn.

Yet, Figure 21 also exhibits a lower unit labour cost ratio in High Productivity sub-industries for Ontario, compared to its peers. Though this may suggest a cost advantage for these High Productivity Ontario firms, this may also in part be indicative of higher wage premiums in US jurisdictions. This could signal the peer jurisdictions' greater ability to attract talent through higher labour compensation relative to total output in these High Productivity sub-industries.

FIGURE 21
Labour input cost ratios in Ontario and North American peer states by productivity groups



Source: Statistics Canada, CANSIM Table 383-0010, 326-0021, 379-0025; OECD; US Bureau of Economic Analysis; and US Current Population Public Use Microdata Survey (PUMS)

Capital costs

In addition to skilled labour, a pivotal element to manufacturing production success lies in the investment of physical capital. Investment into new capital is a critical condition for Ontario manufacturers to compete globally. It is through these investments in machinery and equipment (M&E) that firms can equip workers to produce more sophisticated goods and allow for new technology to enter the production process.

Overall, Ontario firms continue to under invest in M&E compared to firms in the United States. This, in turn, contributes to the observed productivity gap. In fact, this lag in capital investment is attributable to as much as 17 percent of Ontario's entire GDP gap against its US peer jurisdictions.[17]

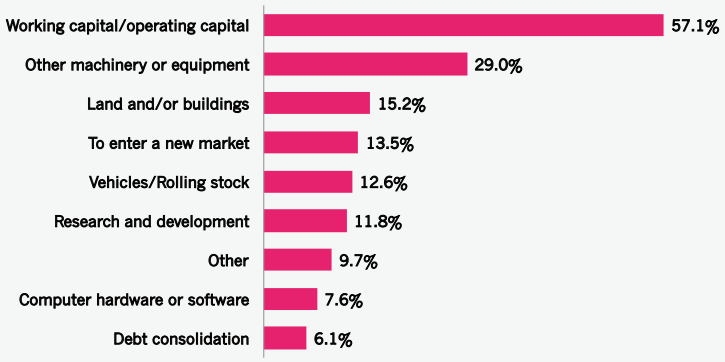
Physical capital encompasses building assets, engineering infrastructures as well as machinery and equipment. M&E can be further divided into two broad groups, information and communications technology (ICT) M&E, and non-ICT M&E.

Information and communications technology M&E refers to a firm's investment in computers, telecommunications and software; while non-ICT M&E comprises all other machinery and equipment including furniture, transportation equipment as well as industrial, agricultural and other machinery.

While there is little evidence of a gap in capital intensity, that is, in the use of capital in the actual production process between Canada and the US, M&E stock and new investments continue to trail.[18] Unfortunately, data limitations don't allow for a breakdown at a provincial level for the manufacturing sector.

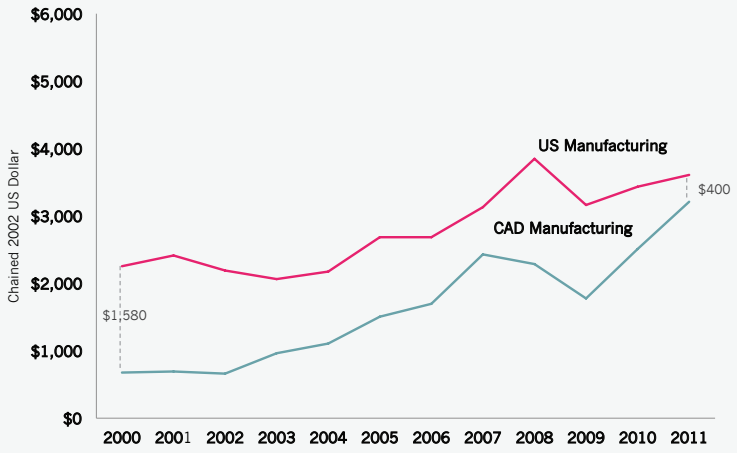
The Centre for the Study of Living Standards (CSLS) identifies increasing efficiency and reduced costs as the main drivers of adopting ICT M&E, with 22 percent and 15 percent of all Canadian firms respectively citing these as factors for ICT adoption. However, as of 2012, only 10.8 percent of all new capital investments in Ontario were created by the manufacturing sector; less than 60 percent of which were new investments of M&E.[19]

FIGURE 22
Intended use of debt financing by manufacturing SMEs



Source: Statistics Canada, CANSIM Table 383-0022, 383-0010, 379-0025, Labour Force Survey microdata; US Bureau of Economic Analysis; and US Current Population Public Use Microdata Survey (PUMS)

FIGURE 23
Total ICT investment per worker between US and Canada



Source: CSLS Database of Information and Communication Technology (ICT) Investment and Capital Stock Trends: Canada vs. United States, available online: http://www.csls.ca/data/ict.asp

An Industry Canada survey for small and medium enterprises also illustrates the investment habits in the manufacturing sector. Based on the 2011 *Survey on Financing and Growth of Small and Medium Enterprises*, 57 percent of respondents cited working capital as the intended use of debt financing. This contrasts significantly with R&D spending or computer hardware or software investments, which scored only 11.8 percent and 7.6 percent of manufacturing SMEs responses respectively (see Figure 22).

Ontario's relative under investment of business-sector M&E vis-à-vis its international peers is not a new problem.20 More worryingly, despite the lower relative price of M&E as a result of the recent appreciation of the Canadian dollar, capital intensity in Ontario continues to decline at an average negative growth rate of -0.3 percent per year.[21]

However, a further decomposition of M&E into ICT and non-ICT investments shows a less dismal picture. As Figure 23 illustrates, the gap in ICT investments per worker relative to the US has narrowed, from an average of $1,500 of ICT investment per worker, to $400 (in 2002 chained US dollars). The narrowing gap in the manufacturing sector contrasts starkly with overall business-sector ICT investment, which has instead widened from $1,600 to $2,300 over the same period.

To identify the degree of capital used in production, we apply capital output ratios, i.e. capital expenditures on M&E as a percentage of output (see Figure 24).

Naturally, capital intensity is highest in High Productivity industries. But interestingly, only High Productivity industries show an increasing trend in capital output ratios, outperforming the overall manufacturing sector and the total economy average. This is a positive sign since increasing capital output ratios over time suggest increasing technological progress. This trend is indicative of future productivity growth and provides further rationale on policies that promote High Productivity industries.

As Figure 25 illustrates, ICT investment prices have decreased more sharply in Canada compared to the US, with a 4.8 percent average annual fall in ICT prices between 2000 and 2011, versus 3.3 percent in the US over the same period. The falling trend of Canadian ICT investment prices can partially be attributed to the appreciation of the Canadian dollar over this period.[22]

Even more notably in Figure 26, the prices of ICT in Canadian manufacturing are shown to be falling steeper than ICT prices for Canada's overall business sector. This contrasts with the US, where overall business sector prices have fallen more steeply than prices in the manufacturing industry.

This implies greater affordability of ICT investments for Canadian manufacturers relative to firms in the overall business sector, a further advantage over US manufacturers when prices are compared to US total business sector ICT investment. This trend presents an opportunity for Canadian manufacturers to invest more heavily in ICT M&E now if the sector is to remain competitive in the long run.

Ontario has also made significant headway in restructuring the business tax system to make it easier for firms to invest, through the harmonization of provincial and federal goods and services tax, the elimination of the capital taxes for manufacturing firms in 2007, and the reduction of Ontario's corporate income tax rates.[23] Furthermore, the lower relative price of M&E from the rising Canadian dollar provides additional incentive for manufacturers to invest more heavily in new M&E. However, Ontario manufacturers have yet to take full advantage of these opportunities. Why?

There are a few possible explanations to new capital investments lag. Firm size, access to financing and the issue of scalability remain obstacles for firm expansion. However, risk aversion and lack of competitive pressure are also factors that contribute to the under-investment in machinery and equipment and the widening productivity gap.[24]

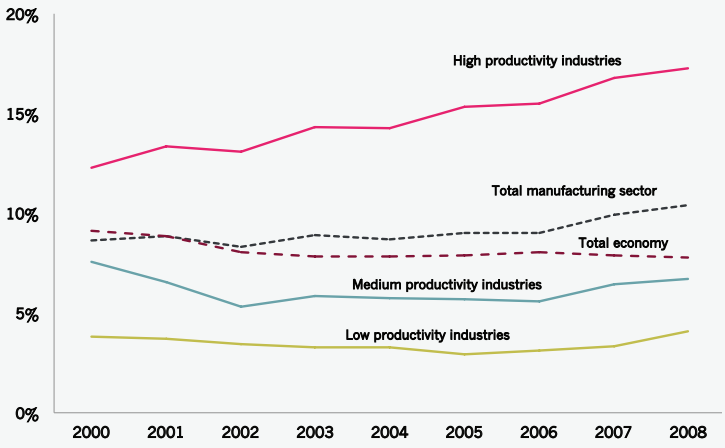
Energy efficiency

In addition to labour and capital, energy and water utilities are important input factors in the manufacturing production process.

Taking into account production numbers sheds some light on the efficiency with which these input factors are being used. Calculating the ratio of real value added to total utility costs for manufacturing in Ontario, Quebec and the rest of provincial Canada shows that Ontario's utility efficiency is actually highest in this group (see Figure 27). In other words, the data suggest that, in general, Ontario's manufacturing sector uses energy and water more efficiently than industries in other Canadian provinces—which might, in part, be due to the larger scale of production in this province.

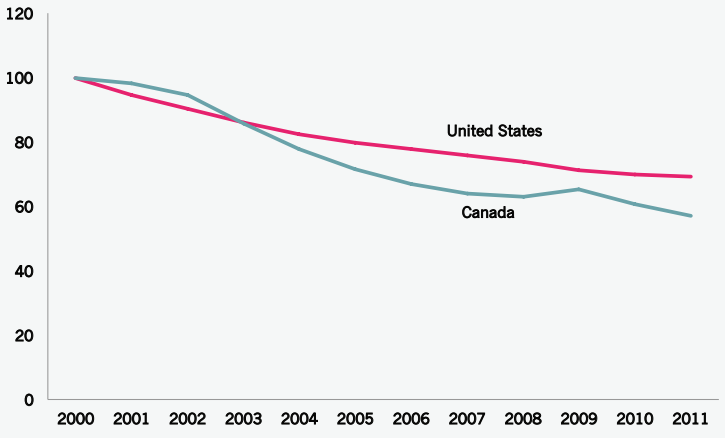
A look at disaggregated industries also reveals that energy is of varying importance as an input factor within the manufacturing sector. Figure 28 below illustrates that petroleum and coal manufacturing, paper manufacturing, primary metal manufacturing, non-metallic mineral manufacturing, chemical products manufacturing and wood product manufacturing are relatively energy intensive compared to other industrial subsectors.

FIGURE 24
Capital expenditures on M&E as a percentage of total output, 2000-2008



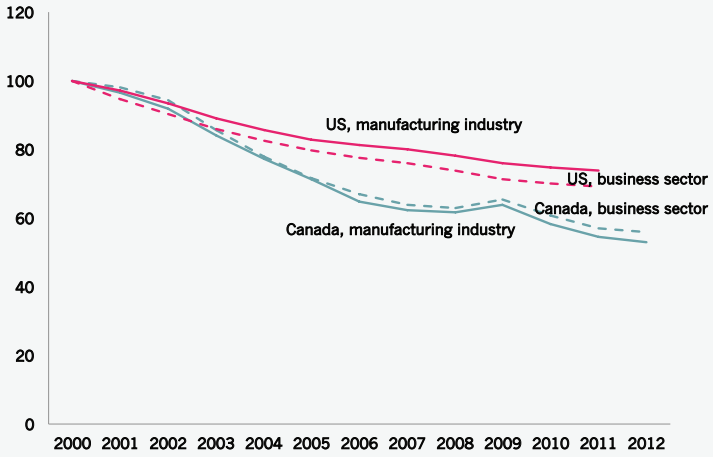
Source: Statistics Canada, CANSIM Tables 379-0025 and 029-0005

FIGURE 25
Price trend of total ICT investments in Canada vs United States (Price Index 2000 = 100)



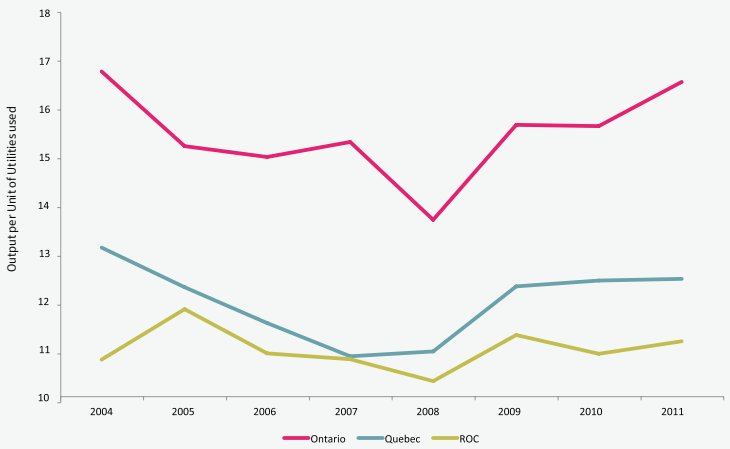
Note: Calculated as the change from total ICT investment implicit price deflators for total computer, communication and software ICT in the business sector in the US and Canada.
Source: CSLS Database of Information and Communication Technology (ICT) Investment and Capital Stock Trends: Canada vs. United States, available online: http://www.csls.ca/data/ict.asp

FIGURE 26
Price trends of ICT Investments, by sector (Price index 2000 = 100)



Note: Calculated as total ICT investment implicit price deflators for total computer, communication and software ICT investment in the US and Canada.
Source: CSLS Database of Information and Communication Technology (ICT) Investment and Capital Stock Trends: Canada vs. United States, available online: http://www.csls.ca/data/ict.asp

FIGURE 27
Utility Cost Effectiveness – Ontario, Quebec and Rest of Canada, 2004-2011



Source: Statistics Canada, CANSIM Table 301-0006, 379-0025

In order to assess Ontario's competitiveness with regard to energy usage, we compare energy efficiency in manufacturing industries relative to that of U. S. peers and peer jurisdictions in Germany. Given that Germany is currently the most productive manufacturing country, an inclusion of German peer jurisdictions in this analysis serves as a useful benchmark for Ontario's manufacturing sector.[25]

With regard to energy usage itself, our analysis focuses on the consumption of electricity and natural gas as input factors in the manufacturing production process. According to data provided by Natural Resources Canada, electricity and natural gas combined amounted for nearly 60 percent of energy consumption in manufacturing in 2010.

At around 30 percent, electricity usage was slightly higher than the consumption of natural gas, which had a share of roughly 28 percent of total energy usage. Oil, another common input factor in energy usage, was not considered in this analysis because consumption data is often missing at the detailed industry level. Moreover, as opposed to prices for electricity and natural gas, the price of oil is largely determined on international markets. Hence, regional variations in cost structures are likely to be less pronounced with regard to oil consumption compared to the use of electricity and natural gas.

To account for a proper comparison between Ontario and its peer jurisdictions, all energy consumption data were re-calculated to KWh.

Figure 29 displays energy efficiency—in terms of electricity and natural gas consumption only—in total manufacturing for Ontario relative to U.S. and German peers. As the ranking shows, Baden-Württemberg is the most energy productive jurisdiction in this group both with regard to electricity and gas usage, followed by Indiana, Bavaria and North Carolina. Out of these 19 jurisdictions, Ontario ranks 17th, or third last, in terms of energy efficiency.

It is important to note here that the results here reflect, at least in part, the composition of the manufacturing sector in each jurisdiction. As such, jurisdictions with a relatively high share of very energy intensive industries, such as paper manufacturing, primary metals and coal, will always end up at the lower end of the ranking.

To get a more detailed picture, it is therefore important to disaggregate the manufacturing sector and compare sub-industries. When this is done for Ontario and its international peers in the U.S. and in Germany, our main result still holds—that Ontario lags most international peers in energy efficiency. This is in line with anecdotal evidence,

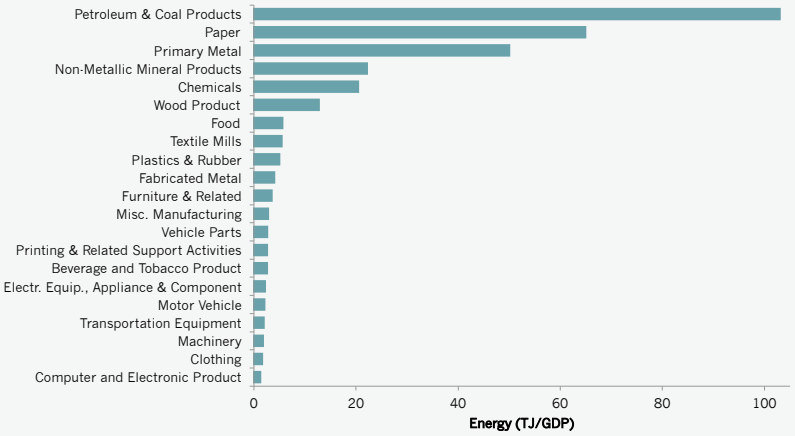
which asserts that comparatively low electricity prices for industrial consumers in the past provided little incentive to upgrade machinery and equipment for more energy efficient production. In more recent years, however, energy costs in Ontario have been increasing and will continue to do so at least over the medium term. This should lead an added incentive to make energy efficiency a higher priority.

Over the past while, there has been ongoing discussion regarding rising electricity prices in Ontario and an increasing concern that price differences relative to U.S. states would harm the competitiveness of Ontario's manufacturers.

Does this concern hold? Figure 30 depicts electricity rates for industrial consumers in Ontario and its U.S. peers from 2000 and 2012. In 2000, the average price for electricity in U.S. peers was 3.4 cents per kWh compared to 5.4 cents per kWh in Ontario. The gap in electricity prices narrowed in subsequent years and reached a difference of roughly 0.7 cents per kWh by 2010.

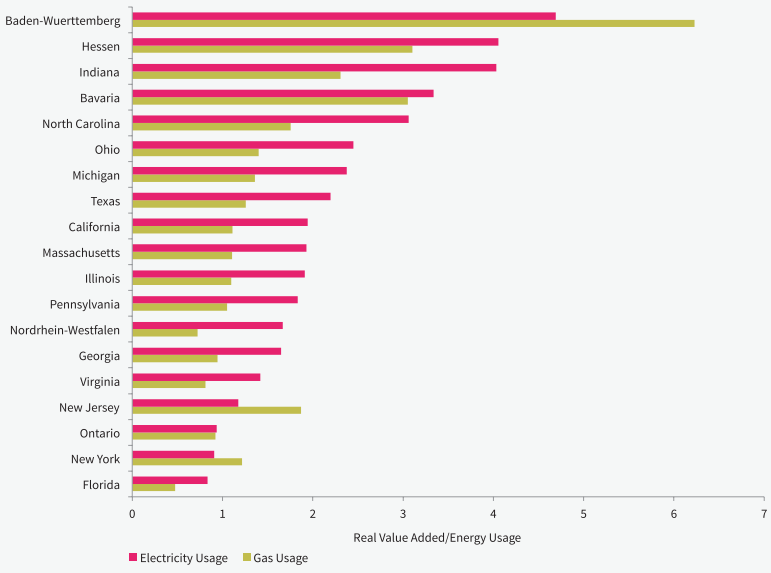
Yet, as Figure 30 also shows, prices began diverging drastically in 2011 and 2012 with Ontario experiencing a significant increase from around 8 cents per kWh in 2010 to 10.9 cents per kWh in 2012. At the same time, electricity prices in U.S. peer states dropped slightly from 7.4 cents per kWh in 2010 to 7.2 cents per kWh in 2012.

FIGURE 28
Energy Intensity in Canadian Manufacturing Industries, 2011



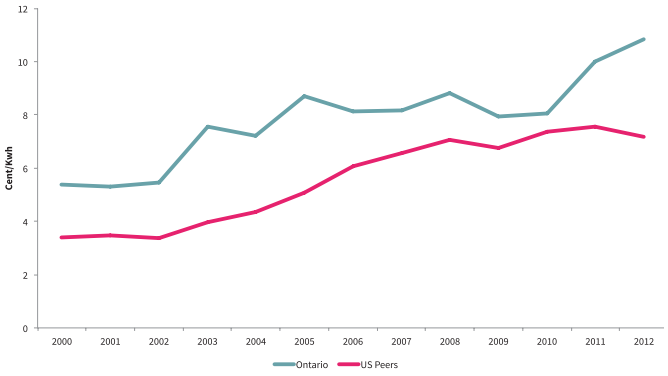
Source: CIEEDAC, Simon Fraser University

FIGURE 29
Energy Productivity Total Manufacturing - Ontario vs. US and German Peer Jurisdictions, 2010



Source: Source: Statistisches Bundesamt, US Energy Information Administration, AMPCO and IESO.

FIGURE 30
Electricity Cost Ontario vs US Peers, 2000-2012 (in Cents/KWh)



Source: NEB and EIA

A direct comparison between selected Canadian provinces and U.S. states illustrates this point further (see Figure 31). In 2000, electricity rates for industrial consumers were 5.4 cents/kWh in Ontario, compared to 3.2 cents/kWh in Michigan, 3.4 cents/kWh in New York and 2.8 cents/kWh in Ohio. By 2010, prices had converged, significantly narrowing these differences. From 2011 onward, however, the gap in prices has started to increase again.

The last column in Figure 31 reveals another interesting fact. While price levels were higher in Ontario compared to most North American peers in recent years, annual price increases occurred at similar speed: from 5.27 percent per year in New York to 7.2 percent per year in Alberta. The only notable exception in this group is Quebec where prices grew on average by 2.65 percent per year.

While comparing electricity costs across jurisdictions is important, a more insightful question might be around the efficiency of Ontario manufacturers in using electricity in production. Figure 32 below illustrates that manufacturers in U.S. peer jurisdictions manage to gain more output using the same amount of electricity compared to Ontario firms. Hence, while companies are not able to control the price of electricity in the province, they can, at least to a certain extent, influence the actual cost of electricity in the production process by addressing the issue of energy efficiency.

A look at international jurisdictions outside North America reveals that prices for electricity are about twice as high in Germany compared to the U.S. and prices for natural gas are about four times as high.

How, then, are German manufacturers able to stay competitive? A recent study by the European Commission shows that the answer is higher energy efficiency, i.e. the smarter use of energy in production.[26]

Thus, with electricity prices set to rise further in Ontario over the medium term, addressing the issue of energy efficiency in manufacturing production will become a crucial issue.

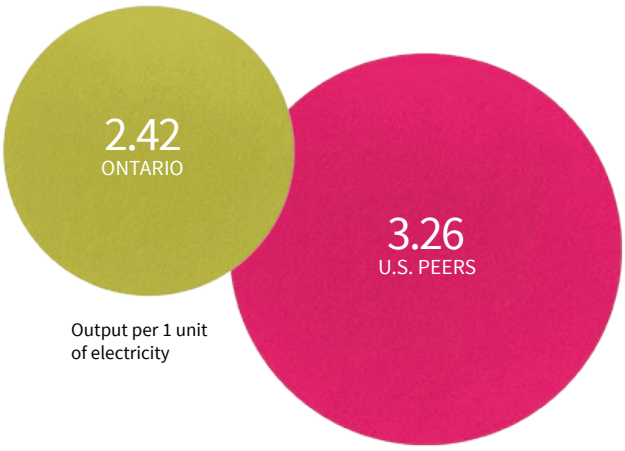
Alongside productivity and the related costs of inputs to production, additional success indicators serve to demonstrate the potential of firms to scale up and the possibilities for sustainable growth. The following two sections analyze Ontario's current situation at the sub-industry level.

FIGURE 31
Electricity Prices in selected Canadian provinces and U.S. states.

JURISDICTION	2000	2005	2010	2012	CAGR
Ontario	5.4	8.7	8.0	10.9	6.03
Alberta	4.6	6.1	7.2	10.6	7.20
Michigan	3.2	4.2	6.5	7.2	6.99
U.S. Peers Avg.	3.4	5.1	7.4	7.2	6.45
New York	3.4	6.4	8.1	6.3	5.27
Ohio	2.8	4.0	5.9	5.9	6.41
Quebec	3.8	4.3	5.2	5.2	2.65

Note: Values in real Canadian dollar; CAGR=year-over-year growth rate from 200-2012
Source: NEB and EIA.

FIGURE 32
Efficiency of electricity use in manufacturing—Ontario vs. U.S. peers



Source: NEB and EIA.

Scalability

A firm's ability to scale up production is an important indicator of success. In order to analyze and quantify the situation for Ontario's manufacturing sector, this analysis focuses on three aspects: high growth firms, survival rates and bankruptcies. Taken together, this can help identify the sector's resilience and those sub-industries with the highest growth potential.

High growth firms

Although productivity is an important ingredient to firm success, it is not the sole ingredient and should not be the end-goal for policymakers. Rather, empirical evidence shows that high growth entrepreneurial firms are responsible for a considerable share of job creation along with the added value they generate in an economy.

Though it is important for policymakers to focus on increasing the number of entrepreneurial manufacturing firms in Ontario, we recognize that growth does not automatically follow. Rather, it is imperative to foster the *quality* of entrepreneurship and to build on the support systems that help promising firms reach their full potential.[27]

As previously noted, the vast majority of manufacturing firms are small, accounting for as much as 86.6 percent of all firms. Small firms may be intentionally small in size to serve different needs. These include niche markets with customized products, since stylized products do not lend themselves to more standardized processes.

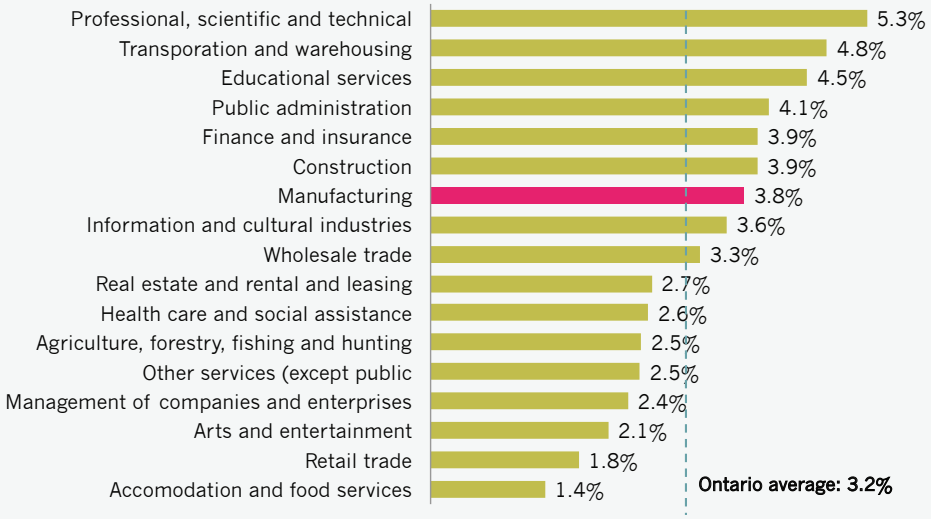
Correspondingly, while this report acknowledges the value smaller firms bring to the sector, it focuses on the opportunities for small firms to expand. Larger firms have a greater tendency to exert the potential direct and indirect benefits on employment, wages and value added on the economy. Empirically, the use of advanced production technology also tends to increase with plant size, with large manufacturing firms being more likely than smaller ones to engage in productivity-enhancing (albeit, riskier) production and process innovations.

This is significant for manufacturing firms in particular, since relatively larger firms (100 employees or more) are as much as 24 percent more productive than smaller firms, even after controlling for industry composition effects, firm age and organizational types. This trend does not appear in non-manufacturing sectors, where the relationship between size and productivity appears to be statistically insignificant within industries.[28]

A smooth and accessible growth path is therefore critical for small and medium-sized manufacturing firms. Expansion support for firms has a significant impact on the economy, especially considering that around 20 percent of the Canadian-US productivity gap can be explained by the relatively larger small business sector in Canada.

Furthermore, assisting smaller firms to scale up would not only increase the quantity and quality of employment, it would also place the necessary pressure for larger existing firms to remain competitive and help steer an innovation-driven manufacturing sector forward. The potential economic benefit becomes even more apparent when taking into account that as much as 58.3 percent of all manufacturing employment flows from total small and medium-sized enterprises in Ontario.[29]

FIGURE 33
Percentage of high growth small and medium-sized enterprises in Ontario (based on employment growth, 2006)



Note: Calculated as a percentage of all enterprises in each respective industry. Mining and oil and gas extraction and utilities were omitted due to data limitations. Not shown are Administrative and support waste management and remediation services (NAICS 56) with growth of 5.3 percent.
Source: Statistics Canada, Small- and Medium-Sized Enterprises Data Warehouse, December 2008

Policy tools could be tailored to firms that demonstrate high growth rates in their early stages. These small and medium-sized enterprises (SMEs) are defined by Industry Canada as businesses with fewer than 500 employers.30 As of 2011, as many as 6.7 percent of all SMEs were manufacturing firms.[31] 'High growth' firms are defined by the OECD as those with average annual growth rates of over 20 percent over a three-year period, with growth recorded in terms of revenue or employment.[32] High-growth firms that are less than five years old are also known as 'gazelles.'

In Ontario, high growth SMEs make up 3.8 percent of all manufacturing enterprises, exceeding the industry average of 3.2 percent (Figure 33). More notably, Ontario's manufacturing sector possesses the highest percentage of gazelles as a fraction of all high growth SMEs. At 33.3 percent, this contrasts with 17.4 percent of high growth SMEs in the professional, scientific and technical service industry, and with the 16.3 percent industry average in Ontario.[33]

The proportion of high growth firms appears to be similar along the three High, Medium and Low Productivity groups (Figure 34). However, the percentage of firm deaths appears higher for High Productivity firms and suggests that these industries also undertake greater risks relative to the lower productivity groups.

While this report focuses on actual business growth rates, caution is placed against firms growing too quickly. Focused attention on *sustainable business growth rates*, which reflects the maximum growth rate in sales that a firm can sustain given its resource and earning capacity, is critical. That said, manufacturing SMEs exhibited zero average growth over the 2000 to 2010 period, well below a sustainable growth rate of 3 percent.[34] This signifies lost economic potential for the manufacturing sector.

FIGURE 34
Growth category of small manufacturing firms by Productivity Groups

PRODUCTIVITY GROUP	MICRO HIGH GROWTH	HIGH GROWTH	GROWERS	STABLE	DECLINED	DIED
High	5.1%	4.0%	13.0%	7.1%	22.6%	48.4%
Medium	6.0%	4.4%	14.5%	7.5%	24.8%	42.9%
Low	4.9%	3.6%	14.5%	7.6%	24.7%	45.2%

Note: Tobacco, leather and allied products, and petroleum and coal product manufacturing industries are excluded due to data limitations.
Source: Bordt, Michael, John McVey and Al Short (2005) "Characteristics of firms that grow from small to medium size: Industrial and geographic distribution of small high-growth firms," Statistics Canada, Catalogue no. 88F0006XIE-No. 005, p. 7

Survival rates

The survival rate of a firm, or the number of remaining firms as a percentage of all business enterprises from the previous year, is another indicator of firm success (OECD, 2013a).[35] Start-ups from the manufacturing industry have one of the highest overall survival rates among all goods-producing sectors.

However, from an international perspective, Canadian manufacturing entrants fare more poorly. Data from the OECD shows that Canadian manufacturing start-ups have a relatively lower survival rate (at 56.8 percent) relative to the average of 17 OECD countries (68.8 percent). This figure also significantly lags behind the US survival rate of 81.9 percent.[36]

On a positive note, Ontario manufacturers have the highest survival rates relative to their provincial counterparts. Despite having marginally lower survival rates than the overall industry in their first year of operations, Ontario manufacturing SMEs also have a higher probability of surviving as time progresses, with a 65.8 percent survival rate by their fifth year of operations (Figure 35). This is an encouraging signal for new Ontario manufacturers.

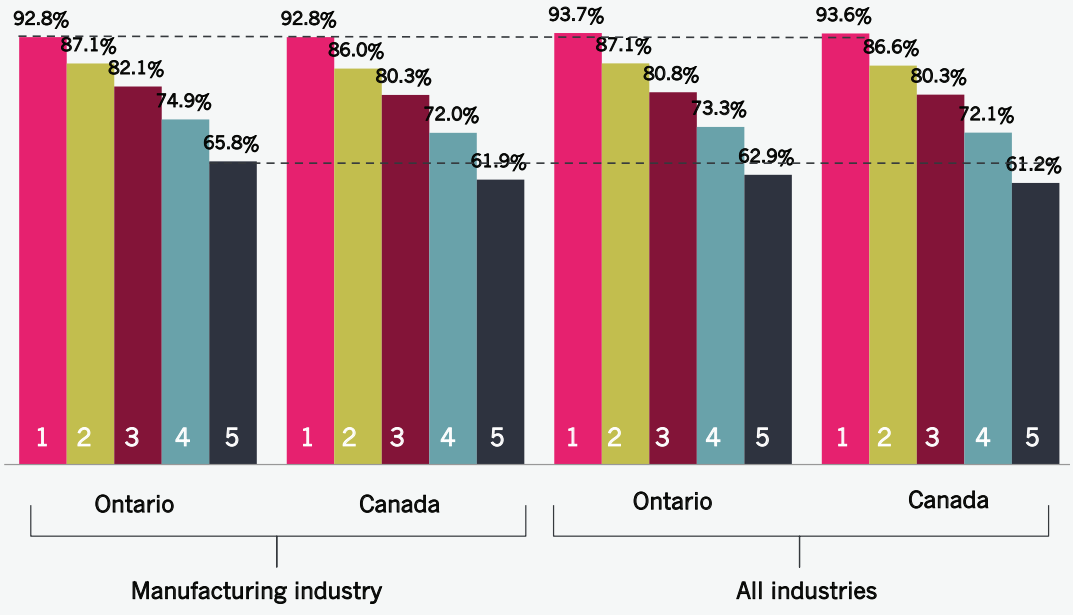
Bankruptcies

In general, the early years are often the most difficult for new firms, with external shocks and internal deficiencies (such as management and financing issues) having the biggest influence on bankruptcy.

Over the course of 2004-2009, Ontario experienced a little over 2,500 business bankruptcies per year, with manufacturing firms accounting for an average of 10 percent of total bankruptcies annually.[37]

According to a recent Industry Canada survey, respondents identified demand fluctuations, increasing competition and shortage of labour as their three top external obstacles to growth (see Figure 36). Obtaining financing was also cited more frequently as an external obstacle for manufacturing SMEs compared to the overall SME average. In a similar vein, manufacturing SMEs cited maintaining sufficient cash flow as an internal obstacle. Interestingly, “devoting too much time to day-to-day operations” is frequently observed as an internal obstacle, and addresses a possible area of concern for new manufacturing start-ups.

FIGURE 35
Survival rates for SMEs over 5-year period



Note: Percentage of SME firms entering in 2001 and excludes firms with revenue less than $30,000
Source: Statistics Canada, Small- and Medium-Sized Enterprises Data Warehouse, December 2008.

FIGURE 36
Survey responses on obstacles to growth for small and medium enterprises

	MANUFACTURING SMES (%)	ALL SMES (%)
EXTERNAL OBSTACLES TO GROWTH		
Shortage of labour	37.2	33.1
Fluctuations in demand for your products or services	62.8	52.2
Obtaining Financing	22.6	16.8
Government regulations	32.9	33.5
Rising costs of inputs	64.9	63.2
Increasing competition	45.3	47.9
Other	24.9	22.2
INTERNAL OBSTACLES TO GROWTH		
Managing debt level	19.8	18.3
Maintaining sufficient cash flow	42.1	37.2
Lack of monitoring business operations to make improvements	21.1	16.3
Lack of knowledge about competitors or market trends	17.4	13.3
Devoting too much time to day-to-day operations	46.1	38.4
Recruiting and retaining employees	38.3	39
Other	9.5	9.4

Note: Based on a survey question "Which of the following of the following obstacles external [and internal] to your business are serious problems for the growth of your business?" where respondents could choose multiple response categories.
Source: Industry Canada (2011) *Survey on Financing and Growth of Small and Medium Enterprises*, 2011

Financing

Financing is generally divided into two categories: debt financing and risk capital financing. Debt financing consists of lines of credit, business loans, commercial mortgages and personal loans, which are generally the most frequently used financing instruments.[38]

Manufacturing SMEs respondents in the Industry Canada survey were more likely to identify domestic chartered banks as their main provider of external financing at 60.2 percent of all manufacturing firms compared to 55.3 percent of all SMEs (see Figure 37). Generally, the average amount of debt financing requested for manufacturing firms was also higher than the average SME application.

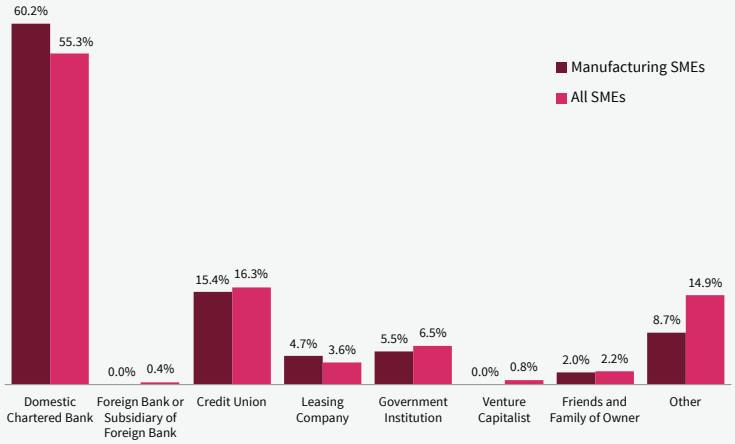
In 2011, the average amount requested for manufacturing firms equated to $296,000 versus professional, scientific and technical SMEs, which requested on average $114,000 over the same period. On the other hand, the cost of debt financing was also slightly lower, with the cost of borrowing averaging 6.6 percent for manufacturing SMEs, versus an average of 6.7 percent interest rate for all SMEs.

Anecdotal evidence suggests a financing gap for SMEs to borrow from many banking institutions, is due to the inability of many entrants to display a positive cash flow. As such, some entrants may also seek access to capital through a second type of financing, or seek a combination of the two.

The second type of financing, risk capital financing, refers to equity or quasi-equity investments and includes, but is not limited to, venture capital investments, angel investors, buy-outs, mezzanine financing and initial public offerings.

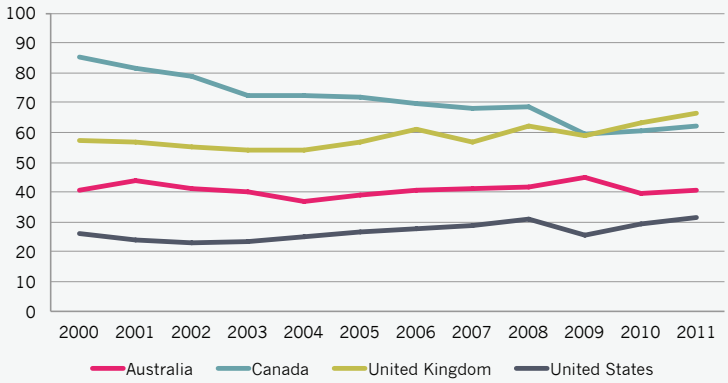
However, access to adequate financing is often limited due to a small and fragmented system of investment support and a diminishing supply of venture capital funds. The supply of venture capital in Canada has been in decline for some time, and is symptomatic of weak and diminishing annualized investment returns over time.

FIGURE 37
Main provider of external financing in Canada (2011)



Note: Data under Foreign Bank or Subsidiary of a Foreign Bank and Venture Capitalist for manufacturing SMEs missing due to data suppression
Source: Industry Canada (2011) Survey on financing and growth of small and medium enterprises

FIGURE 38
Trade as a percentage of GDP in selected countries



Source: OECD (2013), online data available http://stats.oecd.org/

Furthermore, the restrictiveness behind small businesses' ability to access capital is also often due to the pervasiveness of uncertainty and information asymmetries between financiers and entrepreneurs. Therefore, it may be better not only to target the lack of financing problem but also confront the information asymmetries causing this market failure.[39] In this case, policy makers need to be mindful of two significant challenges that are inherent to this mechanism—moral hazard and uncertainty.

Therefore, the answer may not lie in policy options that seek to increase successful ventures through more funding in public venture capital funds. Rather, policymakers must address the factors behind poor annualized returns for investments, as well as the information asymmetries between venture capitalist and entrepreneur. Greater transparency and accessibility are key elements to reduce this financing gap; only then will the supply of venture capital funds follow.

Sustainable growth

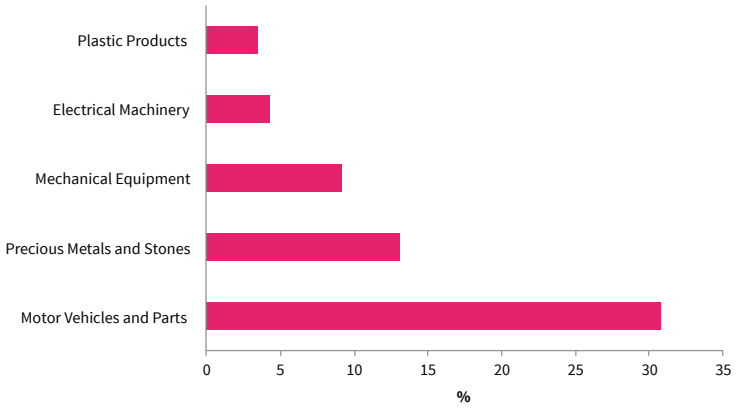
A final aspect in determining success factors of the manufacturing sector is sustainable growth. As mentioned above, sustainable growth in this context is defined as the maximum growth rate a firm can achieve while remaining consistent with the company's existing financial policy. A growth rate higher than the rate of sustainable growth would force the company to leverage its financing.

Increasing the potential for sustainable growth includes increased access to export markets, higher levels of foreign direct investment (FDI), the ability to innovate and the sufficient availability of the talent and skills needed for a modern manufacturing sector. This section will take a closer look at these factors to determine Ontario's current situation.

Exports

Canada is a trading nation. Figure 38 displays trade to GDP ratios for selected countries. As shown, Canada's trade intensity is comparatively high, an unsurprising fact given our relatively small population and smaller domestic market. In other words, trade is essential for Canada's economic success and the manufacturing sector is an integral part of the tradable sector.

FIGURE 39
Ontario's Top 5 International Exports, 2011



Source: Ontario Ministry of Finance, Ontario Fact Sheet July 2012.

Manufacturing plays an important role in an increasingly globalized world. According to the World Trade Organization (WTO), manufacturing's share of global merchandise trade amounts to 67 percent. Taking a regional perspective, the share of trade is highest in Asia (79 percent), followed by Europe (76 percent) and North America (68 percent).

By being highly tradable, manufactures help a country take advantage of faster growing markets and contribute to stabilizing an economy. Moreover, export revenues help pay for the import of goods and services and enhance diversity of consumption in the domestic market.

More importantly perhaps, empirical studies point out that international trade significantly supports economic development. In general, tradable sectors exhibit higher productivity and wages as well as a greater tendency for innovation and research. Hence, the tradable sector, of which manufacturing is an integral part, is a key driver of economic growth.[40]

Figure 39 illustrates the importance of manufacturing for Ontario's exports. Of the top five international exports in 2011, four were from the manufacturing sector. Motor vehicles and parts had the highest share at around 30 percent.

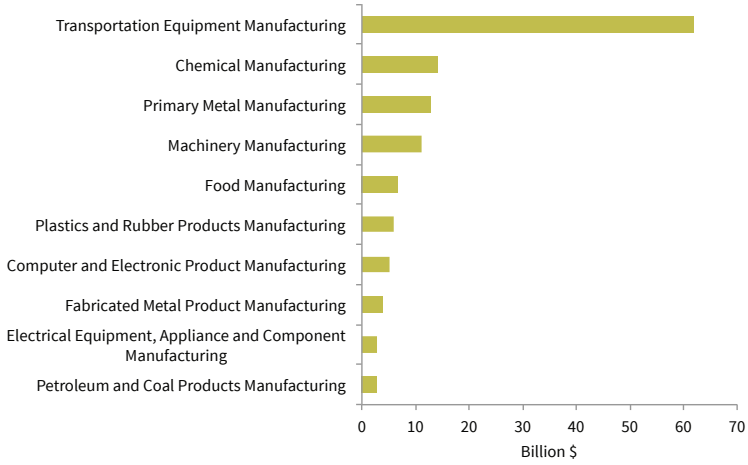
Being internationally interconnected not only opens possibilities to scale up production as a result of a larger market presence, it also facilitates the diffusion of know-how and technology. This enables greater innovation and productivity growth, which can cycle through the economy via increased prosperity. In this context, it is worth pointing out that international interconnectedness includes both direct trade relations, i.e. imports and exports, as well as foreign direct investment (FDI).

Figure 40 lists Ontario's top ten manufacturing industries. As shown, transportation equipment leads the group with a total export value of $61.9 billion in 2012. Of these, around 81 percent, or $50.3 billion, consists of motor vehicle and motor vehicle parts manufacturing. The second highest manufacturing export revenues in 2012 came from chemical manufacturing ($14 billion), closely followed by primary metals ($12.8 billion) and machinery ($11 billion).

Of these ten sub-industries, five fall into the category of High Productivity industries, four fall in the category of Medium Productivity industries and one, namely fabricated metals, falls into the Low Productivity group.

Looking at Ontario's manufacturing export performance over time reveals sectoral patterns at the international level. More precisely, over the past decade total manufacturing exports declined by $17.5 billion, from $156.7 billion in 2003 to $139.2 billion in 2012. In fact, of Ontario's top

FIGURE 40
Ontario's top ten manufacturing exports by industry in 2012 (in billion $)



Source: Industry Canada (2013) online data available http://www.ic.gc.ca/eic/site/tdo-dcd.nsf/eng/Home

ten manufacturing exports, six industries experienced a drop in foreign demand since 2003, whereas four, namely chemical manufacturing, primary metal manufacturing, food manufacturing and petroleum and coal products manufacturing, saw export values increase.

The decline in exports in the affected sub-industries is likely due in large part to the drop in demand in the U.S. market. As Figure 41 illustrates, the U.S. is the dominant export market for Ontario's manufactured commodities. Of Ontario's top five manufacturing exports, between 86 percent and 97 percent are destined to our southern neighbour—the only notable exception here is primary metal manufacturing with a U.S. export share of 69 percent. Of Ontario's total exports, 78.2 percent were exported to the U.S. in 2012, a slight increase of about 1 percentage point compared to 2011. The second largest export destination was China, which received 3.5 percent of manufactured goods from Ontario, followed by the U.K. with 1.7 percent. It is noteworthy that the share of Ontario's manufactures shipped to the EU and the BRICs nations (i.e., Brazil, Russia, India and China) both decreased from 7 percent and 4.9 percent respectively in 2011 to 6.5 percent and 4.5 percent respectively in 2012.

Research suggests that Ontario firms operating at a global level are generally more successful outside of North America after having established a strong footing in the U.S. market. As a consequence, trade with the U.S. will remain of great importance for Ontario firms. Yet, given the risks involved in a high exposure to one single market, efforts should be undertaken to further expand and diversify Ontario's export markets. It appears that the recent financial crisis could act as a catalyst in this respect. Before the crisis, a majority of exporters were largely content with the U.S. as their main export destination—especially while the Canadian dollar was still fairly low. With the U.S. in a long recovery, a sense of urgency to diversify has developed which might help exporters to overcome their risk aversion and concerns related to new market expansion.[41]

For inter-provincial trade, there is also room for improvement in Ontario's goods sector. In fact, goods exports from Ontario to other provinces actually declined over the past decade, from 8.7 percent of GDP in 2000 to 7.7 percent of GDP in 2010.[42] Within Canada, Quebec is Ontario's most important export destination receiving about 42 percent of Ontario's merchandise. About 20 percent of inter-provincial exports are shipped to Alberta, followed by British Columbia at around 14 percent. Food, transportation equipment, primary metals and chemical products top the list of Ontario's inter-provincial exports.

Another important aspect of international connectedness is foreign direct investment (FDI). Inflows of FDI benefit an economy for a variety of reasons. First, foreign firms operating in Canada are more innovative and more productive than their Canadian counterparts. As a result, they pay higher wages which increases tax revenues.[43]

Second, as foreign companies import significant amounts of technology from their parent companies, important technological spillover effects are generated.[44]

Third, empirical evidence shows that inward FDI has led to an increase in head office functions in Canada, which is related to high-value employment such design and engineering.[45]

This contradicts fears about a "hollowing out" effect from FDI and illustrates its importance, especially for an economy aiming to foster employment at the upper end of the value chain. Finally, inflows of foreign direct investment help lower capital cost as they increase the supply of capital in the host country. This can help to spur further investment and stimulate overall economic activity.

According to the Financial Times' fDi Report (2013), Ontario received 123 FDI projects in 2012 making it the third most attractive FDI destination in North America, behind California with 205 projects and California with a total of 146 investment projects. A closer look at disaggregated numbers reveals, however, that the manufacturing sector does not fare particularly well in this context.

While manufacturing is still the biggest recipient of FDI in Canada, its share of total FDI has been declining continually from 43.5 percent in 2000 to 28.6 percent in 2012.[46] In fact, the only economic sectors experiencing an increase FDI shares are mining and oil and gas extraction, from 10.2 percent in 2000 to 18.9 percent in 2012, and management of companies and enterprises, from 8.5 percent in 2000 to 19.2 percent in 2012.

FIGURE 41
Ontario's top ten manufacturing exports in 2012 and top five export destinations

Top 10 Manufacturing Industries

1 TRANSPORTATION EQUIPMENT

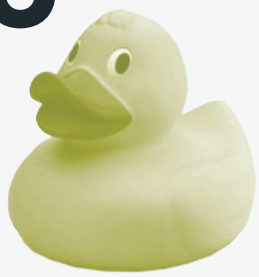
2 CHEMICALS

3 PRIMARY METALS

4 MACHINERY

5 FOOD

6 PLASTICS & RUBBER



7 COMPUTER & ELECTRONICS

8 FABRICATED METAL

9 ELECTRICAL EQUIPMENT

10 PETROLEUM & COAL PRODUCTS

Top 5 Export Destinations of Industries

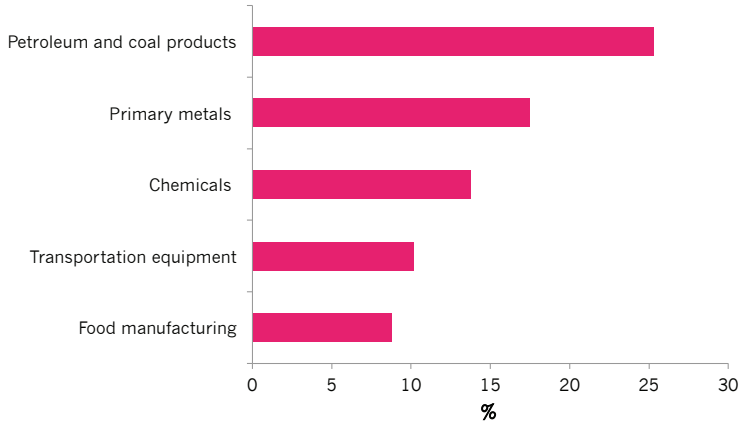
INDUSTRY	DESTINATION				
	1	2	3	4	5
Transportation Equipment Manufacturing	**United States (96.7%)**	Mexico (1.2%)	Saudi Arabia (0.8%)	France (0.4%)	United Kingdom (0.3%)
Chemical Manufacturing	**United States (86.5%)**	Netherlands (2.8%)	United Kingdom (2.6%)	China (2.3%)	Japan (1.7%)
Primary Metal Manufacturing	**United States (69 %)**	Norway (15.3%)	United Kingdom (11.1%)	Mexico (2%)	China (1.4%)
Machinery Manufacturing	**United States (86.1%)**	China (3.6%)	Mexico (2.4%)	France (2.2%)	Germany (2.1%)
Food Manufacturing	**United States (94.3%)**	Mexico (1.7%)	Japan (1.5%)	China (0.8%)	Saudi Arabia (0.7%)
Plastics and Rubber Products Manufacturing	**United States (97.1%)**	Mexico (0.9%)	China (0.6%)	United Kingdom (0.4%)	Japan (0.3%)
Computer and Electronic Product Manufacturing	**United States (80.1%)**	United Kingdom (5.7%)	China (4.6%)	Germany (2.3%)	Japan (2.0%)
Fabricated Metal Product Manufacturing	**United States (92.6%)**	Mexico (2.3%)	China (1.6%)	Germany (1.4%)	United Kingdom (0.7%)
Electrical Equipment, Appliance and Component Manufacturing	**United States (87%)**	Mexico (3.0%)	China (2.7%)	Germany (2.2%)	France (2.0%)
Petroleum and Coal Products Manufacturing	**United States (91.6%)**	Netherlands (5.6%)	China (1.3%)	United Kingdom (0.7%)	Mexico (0.4%)

Source: Industry Canada (2013) online data available http://www.ic.gc.ca/eic/site/tdo-dcd.nsf/eng/Home

Disaggregating the data on the manufacturing sector further reveals that petroleum and coal products manufacturing received the largest share of manufacturing FDI in 2012, with 25.3 percent. This was followed by primary metal manufacturing with a share of 17.5 percent and chemical manufacturing with 13.7 percent.

In fact, as Figure 42 reveals, the top five FDI receiving manufacturing industries in Canada all belong to the High Productivity group. Yet over the past decade only three manufacturing industries experienced an increase in their FDI shares, namely petroleum and coal products manufacturing, primary metal manufacturing and food manufacturing. All other manufacturing sub-sectors saw their shares decline since 2000.

FIGURE 42
Top five FDI receiving manufacturing industries in 2012 (as a percentage of total manufacturing FDI)



Source: Statistics Canada, CANSIM Table 376-0052

Given how vital FDI inflows are with regard to innovation, productivity and the diffusion of technology, there is a need to strengthen efforts in order to attract more capital investment from abroad.

Innovation

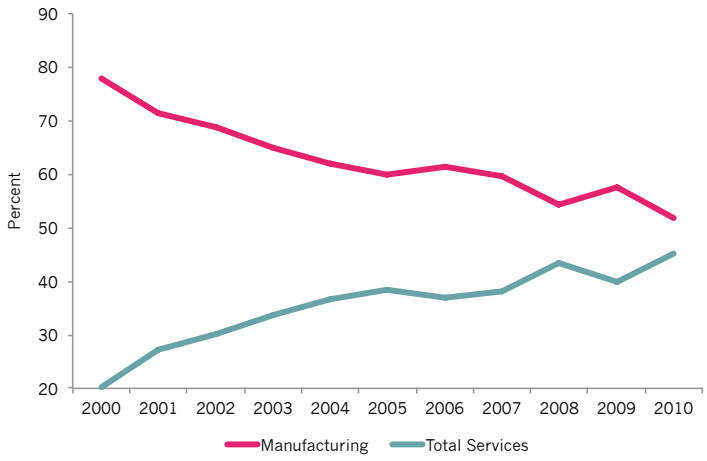
An important feature of manufacturing is its substantial role in innovation. In most advanced countries the manufacturing sector accounts for the lion's share of business R&D spending and employs the majority of research personnel (including engineers). Since innovation is highly correlated with productivity growth and competitiveness, a vibrant R&D environment is a cornerstone of a successful economy in a globalized world.[47]

While Ontario's manufacturing share of GDP accounted for around 15.1 percent in 2010, its R&D expenditure accounted for roughly 53 percent of total business R&D expenditure in that year (see Figure 43).[48]

Manufacturing contributes roughly three and a half times its proportional share to Ontario's R&D activity, making it the biggest private sector contributor. On the other hand, the trend in Figure 43 clearly indicates a decline in manufacturing share in total business R&D, and signals a shift towards a more service-oriented economy. For manufacturing to stay internationally competitive, policy efforts should be targeted at bolstering incentives to increase business R&D levels.

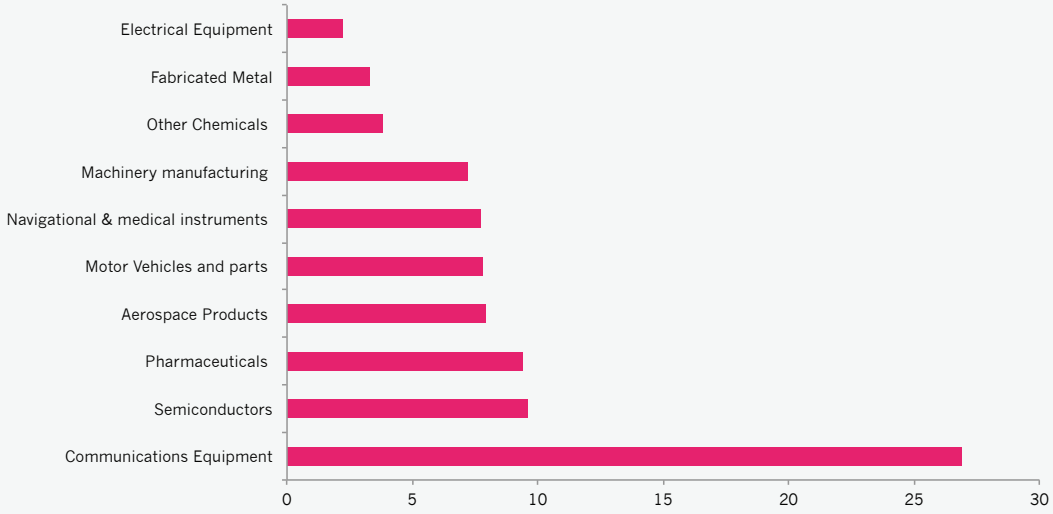
Within the manufacturing sector, the majority of R&D activity is carried out by communications equipment manufacturing, followed by semiconductor manufacturing

FIGURE 43
Business R&D Expenditure Shares, Ontario 2000-2010



Source: Statistics Canada, CANSIM Table 358-0161

FIGURE 43
Share of Business R&D Expenditure in Manufacturing Industries, Ontario 2010



Source: Statistics Canada, CANSIM Table 358-0161.

and pharmaceuticals (see Figure 44). Aerospace products, motor vehicles and parts manufacturing and machinery manufacturing are also among the top ten.

Innovation is strongly associated with SME success, where new entrants serve as a conduit to fresh ideas. But innovation performance, commonly evaluated through the number of patents and R&D spending, is an imperfect measure since these indicators are often dependent on sector-specific characteristics.[49]

This report, therefore, defines innovation more broadly as the implementation (via commercialization or adoption) of a new or significantly improved product or process, or new method in business practice, or a combination of these. Some of these intangible improvements are often more difficult to measure.[50]

Canadian firms continue to fall behind their US counterparts in innovation. But now, more than ever, manufacturers in Ontario have a significant opportunity to improve their innovation process and products.

A new wave of innovative products and processes

The ubiquity of the Internet has ushered in a new ecosystem of information and usability for Ontario manufacturers. As more and more machines and tools are embedded with sensors and are connected to databases and the Internet, a massive opportunity has emerged for manufacturers to enhance business processes, create new sensor-driven business models and as a result, achieve lower costs and risks.

A wide range of hardware devices are increasingly being equipped with the ability to sense the environment and communicate, and in the process forging a booming technological development described as the 'Internet of Things'. These devices have the ability to relay information in real time (allowing businesses to respond quickly to change) as well as increase precision and raise efficiency in manufacturing operations. They can also more closely and continuously monitor environments and even take corrective action, minimizing damage, risk and cost.[51]

These new technological advances (such as the use of sensors, software and communications technology) could potentially revolutionize the manufacturing industry, with developed nations seeing an increase in value creation through smarter, more efficient and more adaptive production. Often termed the fourth Industrial Revolution or

'Industry 4.0,' this development has led the German federal government to seed €200 million to industry associations, researchers and businesses to form an implementation strategy and lead in the supply of these cyber-physical systems (CPS). In this context, Germany's National Academy of Science and Engineering points to a 30 percent increase in industrial productivity from these new manufacturing technologies.

Ontario manufacturers have significant room for improvement in terms of business process innovations. Best practice operation strategies such as lean manufacturing, just-in-time operations, and other management competencies are not new approaches, but they continue to offer key insights in improving firm performance, reducing costs and maintaining profitability in an increasingly competitive business environment.

Although Ontario manufacturers rank high in the adoption and implementation of overall effective operations processes, they continue to lag their US peers in operations tracking and review, as well as performance and people management.

A new wave of hardware start-ups

Technological progress has also generated an exciting era of new and innovative hardware start-ups. These high-value firms are germinating from the design, production and commercialization of new "smart" hardware technology. Examples include Thalmic Labs, a Waterloo-based entrepreneurial firm that has produced a new gesture controlled armband, and Toronto's Clear Blue Technologies, which has combined hardware to make the first smart "off-grid" communications, remote controlled management system using small solar wind turbines. This budding industry combines manufacturing with mechanical engineering, design, and software to create an evolutionary era of intelligent hardware.

Over the past ten years, applied research at the College level has grown significantly. The key strategy here is to bring together students and industry partners and conduct real-life projects. In these settings, students are exposed to business strategies, such as pricing and positioning new products and can turn acquired knowledge into practice. Business partners profit through the ability to test, prototype and commercialize new products.

Currently, academic institutions like George Brown College, Seneca College and Humber College, to name a few, are helping students and small start-ups by providing rapid prototyping facilities and professional networking opportunities that help get product to market. In addition to the curriculum of combining mechanical engineering, design and electronic education, these institutions liaise with industry partners who seek engineering and technology design help, drawing from the talents of students and facilities (using 3D printing and other rapid prototyping technologies) to create new innovative machines that aid in their own business processes.

Successful partnerships have led to the design of a new lightweight portable construction crane for SOS Customer Services Inc., and the design of an automated, user-friendly medication dispenser for people with serious mental illnesses for the Centre for Addiction and Mental Health (CAMH).[52]

Another example is a project funded by the Natural Sciences and Engineering Research Council of Canada (NSERC). Students at Centre for Development of Open Technology (CDOT) at Seneca College partnered with Fivel, a Mississauga-based Software company, to design and build and e-learning module for enhanced technology adoptions. The modules incorporate a game design and interactive principles with a high level of engagement and learning. To prototype the module, software tools developed at Seneca were used.

The success stories emanating from joint efforts of colleges, universities and the private sector present a strong case for pursuing such collaboration further in Ontario. Such efforts would serve to improve scalability and commercialization potential, which remain significant issues for budding high-technology manufacturing firms. In the case of high technology hardware manufacturing start-ups especially, these entrepreneurial firms often face the challenge of developing only a couple hundred prototypes before full

commercialization, which are often prone to tweaks and modifications before final market phase. In many cases, entrepreneurs find scaling difficult since production is usually conducted either in-house at a very small scale or by contracting other firms who could only create very large and fixed batches of one version of the product.

In Ontario, manufacturing firms are often either really small or really large. The relatively low amount of medium-sized firms creates the challenge that full economies of scale cannot be realized by many companies. This issue is not limited to high technology firms. Although this report cannot necessarily assume a linear progression for firm growth, the paucity of medium-sized firms provides grounds for further focused research on this issue.

Talent and skills

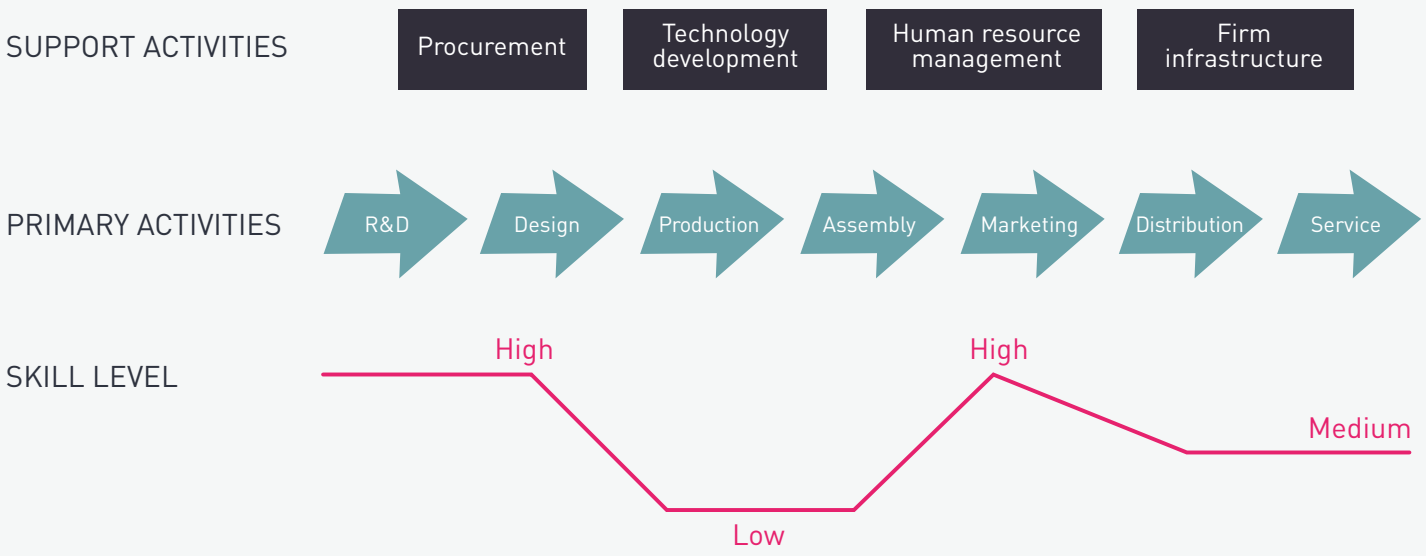
The importance of skills and talent for a vibrant manufacturing sector in Ontario cannot be stressed highly enough. This notion is emphasized in Ontario's 2013 Jobs and Prosperity Council report, which states that "a talented and adaptable workforce is at the heart of innovative economies".[53]

As mentioned, the skills needed in a specific sector largely depend on a country's position on the global value chain. Figure 45 shows a stylized value chain for a certain product from development to final distribution and service.

Rearranging the tasks along the value chain according to skill intensities gives a clearer understanding of skill requirements in manufacturing located in a highly developed economy. In a world where global value chains have become a reality, tasks such as assembly and production are often being outsourced to lower-wage jurisdictions or done by new machines and robots. For a developed economy this means that focus should particluarly lie on skills related to R&D, design, branding and marketing, and sales services.

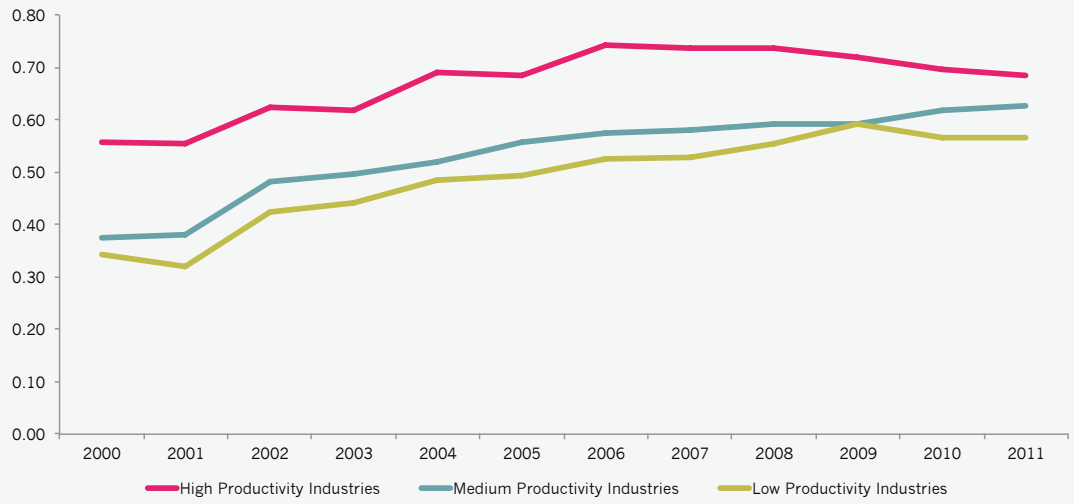
Figure 44 below further illustrates this issue. Calculating the ratio of non-production workers to production workers in Ontario's manufacturing industries reveals the shift in the demand of skills that has occurred over the past decade.[54] More specifically, the demand for non-production workers is shown to have increased in mostly all manufacturing sectors.

FIGURE 45
Skill distribution within the value chain



Source: Adapted from Feenstra, Robert and Alan M. Taylor (2008) International Economics, Worth Publishing, New York, p. 232

FIGURE 46
Ratio of non-production employment to production employment in Ontario manufacturing



Source: Statistics Canada, CANSIM Table 301-0006.

A look at disaggregated data reveals that the only exceptions were in chemical production, where the ratio of non-production and production workers basically remained unchanged, and in computer and electronic product manufacturing. Between 2004 and 2011 this particular industry experienced a sharp decline in non-production employment while production employment remained rather stable. As a consequence, the ratio of non-production to production employment dropped from 0.68 in 2004 to 0.49 in 2011; this is the main driver of the slight fall in the aggregated curve for High Productivity industries depicted in Figure 46.

Similar to most advanced economies, Ontario's manufacturing sector currently faces a shift in skill requirements in the context of an ageing workforce. These issues need to be addressed if Ontario is to keep a vibrant manufacturing industry. A number of other barriers also require timely public policy attention to address talent and skills issues in Ontario.

Risk aversion among Ontario firms, which can lead to under-investment in vocational and workplace training, is one of the bigger challenges. As mentioned in the Jobs and Prosperity Council report, workplace training and lifelong learning are crucial elements in a knowledge-based economy and as such are elemental to modern manufacturing.

Expanding vocational training would also help address the looming threat of skill shortages. Yet, employers might shy away from these measures out of concern that employees would leave once apprenticeships are completed, thus eliminating the benefits of the investment for the employer. In other words, this uncertainty could lead to a market failure and create a sub-optimal economic outcome.

The previous sections diagnosed the challenges Ontario's manufacturing sector faces. In the following sections of the report we focus on what public policy can do to help Ontario's manufacturers to reap the benefits of the new and exciting opportunities brought about through the technological changes described above. In a first step, a regression analysis is applied to identify those factors that contribute to a comparative advantage in advanced manufacturing. This is followed by detailed policy recommendations.

Indicators of success—productivity, scalability and sustainable growth

Productivity

» While labour productivity levels in Ontario's manufacturing sector continues to exceed those of other business sectors, manufacturing's annual average growth rate, at 0.23 percent, falls below that of all others, which have grown by 0.55 percent annually on average in the last decade.

» Ontario's peer jurisdictions outperform the province across all three productivity groups—low, medium and high—with the biggest gap occurring in the high-productivity group, where peers outperform Ontario firms at an average rate of 1.6 times.

» In terms of unit labour cost, while peer jurisdictions have demonstrated a steady decline in labour cost ratios over the last decade, these have remained fairly consistent in Ontario. As a result, since 2006, US manufacturing firms have reversed Ontario's long-standing labour cost advantage.

» Poor energy efficiency is another contributor to lagging productivity in Ontario. Out of 19 peer jurisdictions, Ontario ranks 17th, or third last, in terms of energy efficiency.

» Ontario firms also continue to under invest in M&E compared to US firms, contributing to the observed productivity gap.

» A more favourable trend is occurring in ICT investment, where the gap between US peers and Ontario has narrowed from an average of $1500 to $400 per worker over the last decade. The greater affordability of ICT for Ontario manufacturers presents an opportunity to invest more heavily in ICT and M&E now to remain competitive in the long run.

Scalability

» Smaller manufacturing firms are on average 24 less productive than larger firms—this trend is unique to the manufacturing sector. Expansion support for smaller firms could therefore have significant economic impacts, especially since 20 percent of the Canadian-US productivity gap can be explained by the relatively larger small business sector in Canada.

» Ontario's manufacturing sector possesses the highest percentage of 'gazelles', high growth firms that are less than 5 years old, as a fraction of all high growth SMEs. Developing tailored policy tools that assist manufacturing gazelles to scale up could be particularly worthwhile.

» Assisting smaller manufacturers to scale up could also improve business survival rates. While Ontario firms have the highest survival rates in Canada, overall, Canadian manufacturing start-ups have a relatively lower survival rate, 56.8 percent, compared with the OECD and US averages of 68.8 percent and 81.9 percent, respectively.

» Policymakers must also address the factors behind poor annualized returns for investments, as well as the information asymmetries between venture capitalist and entrepreneurs to narrow the existing financing gap faced by smaller manufacturers.

Sustainable growth

» 'Sustainable growth rates' reflects the maximum growth rate in sales that a firm can sustain given its resource and earning capacity. Increasing the potential for sustainable growth includes increased access to export markets, higher levels of foreign direct investment (FDI), the ability to innovate and the sufficient availability of the talent and skills needed for a modern manufacturing sector.

» Over the past decade total manufacturing exports declined by $17.5 billion, due in large part to the drop in demand in the U.S. market, Ontario's biggest trading partner. With the U.S. in a long recovery, a sense of urgency to diversify has developed among exporters.

» In terms of FDI, while manufacturing is still the biggest recipient of FDI in Canada, its share of total FDI has been declining drastically in recent years. FDI inflows are vital for innovation, productivity and the diffusion of technology; greater efforts are needed to attract more capital investment from abroad.

» Manufacturing R&D, which has been historically strong (contributing roughly three and a half times its proportional share to Ontario's R&D activity) is also declining, signaling a shift towards a more service oriented economy. However, significant opportunity for advancement is emerging from new technological developments and cross-sectoral collaboration.

» Finally, a focus on skills related to R&D, design, branding and sales services, among others, is necessary for developed economies to maintain competitiveness. Demand for non-production workers has already increased in most manufacturing industries in Ontario.

Being internationally interconnected not only opens possibilities to scale up production, it also facilitates the diffusion of know how and technology. This enables greater innovation and productivity growth.

6

Uncovering Ontario's comparative advantage

Ontario should not settle for second-class standards, but position itself as a champion of high technology manufacturing exports. For Ontario to become a world-class leader, it must have a comparative advantage in the export of high-value manufacturing. This section examines the drivers of a region's comparative advantage in the manufacturing industry. To this end, a multivariate analysis is applied to measure the comparative advantage in manufacturing industries and identifies possible drivers associated with high overall manufacturing competitiveness. Understanding the basic factors that create comparative advantage, such as R&D, foreign direct investment (FDI), education, regulatory quality and institutional effectiveness underscores possible policy recommendations to foster higher value added and more competitive firms in the region.

To measure a country's comparative advantage in manufacturing, we use total high technology manufacturing exports as a percentage of total manufacturing output, XHT, as the dependent variable. This represents the market share of high tech manufacturing and acts as a useful barometer for the state of manufacturing as a whole, especially given that high tech manufacturing sub-industries offer the highest output multiplier, or greatest economic returns to the rest of the economy.[55]

Model specification

The data comprises economic indicators for 19 selected OECD countries between 1990 and 2011. A focus on the most developed OECD countries was primarily chosen since these countries generally lead the global market in high technology manufacturing production and are associated with established markets and larger production scales. Data was retrieved from various sources including OECD, the World Bank database, Statistics Canada, EuroStat, the US Bureau of Economic Analysis and other national statistical agencies.

The model analyzes the relationship of comparative advantage (measured as the share of high technology manufacturing exports) with various determinants across the sample countries. All variables, unless otherwise stated, are expressed as a percentage of GDP. These explanatory variables include:

1. Size (SIZE), measured by a country's GDP as a percentage of total selected OECD countries.56 This serves as a proxy for market size which is achieved through larger markets and controls for higher comparative advantage achieved from economies of scale in production;

2. R&D expenditure (RD), which represents gross domestic expenditure on R&D for total business enterprise (as a percentage of GDP);

3. Foreign direct investment (FDI), measured as total inward FDI as a percentage of GDP. This variable acts as a proxy to control

for a country's stock of capital. It is lagged by one year to account for length of time for capital and knowledge to diffuse into a country's production processes. It is expressed as total inward FDI as a percentage of GDP;

4. Resource rents (RENT) which controls for a country's endowment of resources, and represents the sum of oil, gas, coal, mineral and forest rents, as a percentage of GDP;

5. Industry size (INDSIZE), which measures the total size of the production sector as a percentage of GDP. Given that literature reveals a weak relationship between R&D expenditures and high tech manufacturing export, this may in part be explained by the magnitude of the rest of the production sector which absorbs a significant portion of R&D resources. This variable therefore proxies for the size of the sector and controls for R&D intensity taken up by the relatively lower tech production sector;

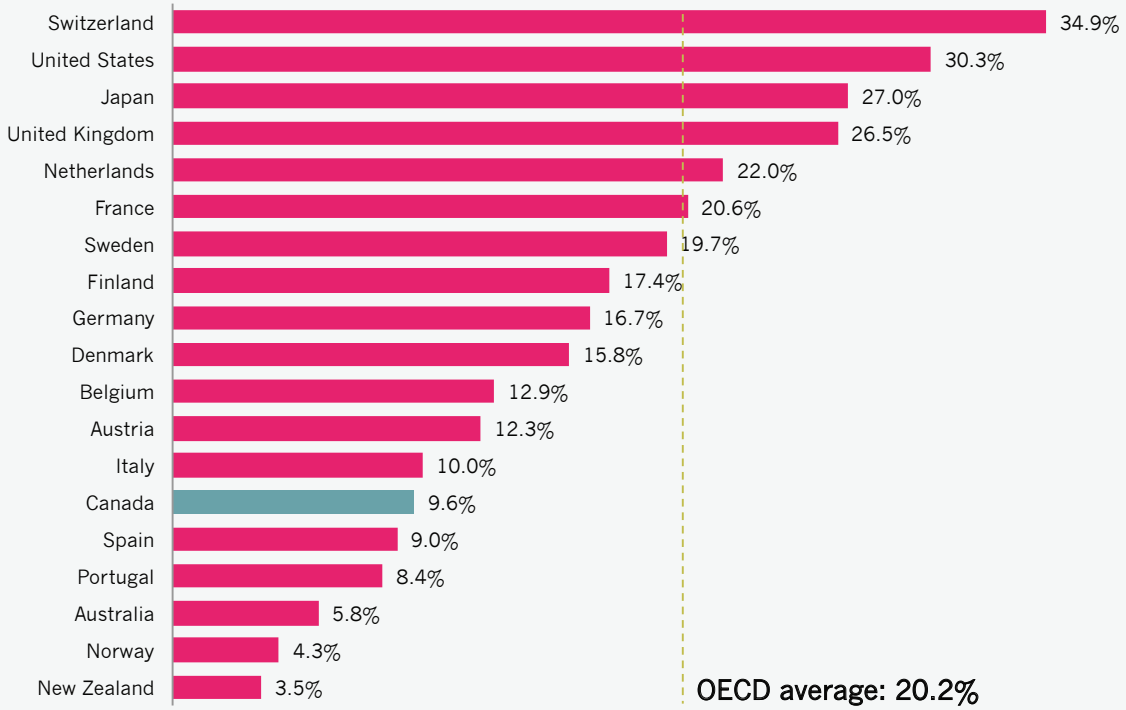
7. Education (EDUC), which is measured as the number of graduates in natural science, engineering, manufacturing and construction as a percentage of total number of OECD graduates. This serves a proxy for all natural science and skilled trades workers and is lagged by two years to account for time spent in job searching and training on the job;

8. Regulatory quality (REG), a variable produced by the World Bank to capture the ability of government and the efficacy of government regulation to promote private sector growth (based on the perceptions of a broad range of businesses, academics, governmental representatives and other professionals); and

9. Government effectiveness (GOV), which is also produced by the World Bank to reflect the perceptions of the quality of government institutions and their ability to formulate and implement public services.

Comparative advantage here is measured by exports of high technology products, as these products possess a high degree of sophistication due to greater value added and a utilization of highly skilled labour.[57]

FIGURE 47
Share of high technology exports in selected OECD countries



Note: OECD average is calculated based on selected 19 OECD countries
Source: OECD Statistics, http://stats.oecd.org

All of this is indicative of a country's competitiveness with regard to innovation and productivity. In this context, Canada ranks dismally in its share of high technology exports, ranking 14th out of the 19 selected OECD countries at 9.6 percent, and well below the OECD average of 20.2 percent (see Figure 47). This suggests a lack of competitiveness and under-utilization of its economic potential vis-à-vis its international counterparts.

The model specification is as follows:

$$XHT_{i,t} = \alpha_{i,t} + \beta_1 FDI_{i,t} + \beta_2 RD_{i,t} + \beta_3 EDUC_{i,t} + \beta_4 REG_{i,t} + \beta_5 GOV_{i,t} + \beta_6 Z_{i,t} + \varepsilon_{i,t}$$

The notations i and t represent country and time respectively. Z denotes the control variables country size (SIZE), production-sector industry size (INDSIZE), and total resource rents (RENT). The model was regressed using the Newey-West estimator to address any heteroskedasticity and serial correlation in the model residuals.

Regression results

Figure 50 displays the results of the regression analysis. Model 4 exhibits the best measure of fit and appears to best reflect the array of policy instruments and decisions inherent in explaining comparative advantage in high technology manufacturing. As the results from the baseline Model 4 show, R&D expenditure, inward FDI, education as well as regulatory quality and government effectiveness have a positive and statistically significant impact on a country's comparative advantage in high technology exports. The findings also indicate that high resource endowments, reflected in resource rents, have a negative influence; most likely through its effects on a country's exchange rate. In other words, there may be Dutch Disease effects.

The biggest impacts on comparative advantage appear to be from R&D expenditure and education. As Figure 48 shows, a one percentage point increase in R&D expenditure is associated with 2.086 percentage point increase in high technology export share. Similarly, a percentage point increase in a country's share of graduates as a total of OECD graduates translate to a 0.738 percentage point increase in XHT (comparative advantage), holding all else constant. This is indicative of higher shares of skilled trades, engineering and natural science labour on high technology production and exports. Institutional factors, as measured as government effectiveness and efficacy of regulation to foster private sector development, also play an important role in promoting comparative advantage.

The model results provide a compass that directs us to the broad factors that influence greater excellence in manufacturing exports and towards a comparative advantage in high-value, high-technology manufacturing goods. The model variables, R&D, FDI, regulatory quality and education broadly shape the policy areas, which we turn to in the next section.

FIGURE 48
Regression model showing the drivers of a country's comparative advantage

	MODEL 1	MODEL 2	MODEL 3	MODEL 4
R&D	8.194*** (0.52)			2.086* (1.76)
FDI		0.308** (0.10)		0.255** (3.01)
REG			0.011 (0.01)	0.022* (1.73)
GOVEFF			0.015 (0.01)	0.020 (1.49)
RENT				-0.008*** (-3.74)
INDSIZE				0.001 (0.48)
EDUC				0.738*** (3.59)
SIZE				-0.155 (-0.93)
CONSTANT	0.054*** (0.01)	0.155*** (0.01)	0.160*** -0.01	0.075* (1.84)
R-SQUARED	0.39	0.02	0.03	-
NO OF	360	399	303	168

Note: Standard errors in parentheses. *, ** and *** represent the statistical significance at the 10, 5 and 1 percent level, respectively.

Comparative advantage in high-technology manufacturing exports is influenced by R&D, FDI, regulatory quality and education.

7

Boosting Ontario's manufacturing sector—recommendations

It has become clear that Ontario does in fact have a highly attractive value proposition to offer existing and potential manufacturers, and it has everything necessary to strengthen its manufacturing sector. Canadian manufacturers will continue to make things in Ontario, global companies will continue to invest in Ontario and successful Ontario firms will continue to invest in production abroad. All three of these activities are good for Ontario.

Ontario's manufacturing sector is likely to employ fewer people than it has historically. This is an inescapable reality regardless of which strategy the provinces chooses. Nonetheless, a strong manufacturing sector with export-oriented global firms has benefits for the overall economy in terms of spillovers in research and development, services and high-quality employment. Realizing the vision for Ontario's manufacturing sector requires concerted action by governments, the private sector and other partners.

Our recommendations are designed to strengthen our comparative advantages and build on our existing value proposition. Many of the recommendations build on and synthesize existing suggestions from studies by many organizations, including the Jobs and Prosperity Council (JPC) and the Institute for Competitiveness and Prosperity, but we also add many others with the goal of sketching out a comprehensive agenda.

When strengthening Ontario's value proposition, it is important to identify those policy tools that will encourage greater investments in those things that will lead to greater productivity: R&D, M&E, ICT and training.

Before outlining the recommendations in detail, an umbrella recommendation is in order.

The federal and provincial governments must make a real commitment to the future of the sector. This requires federal leadership and engagement. Concrete steps would include:

» Working with the province of Ontario to develop a next generation manufacturing strategy that would include aligning policy and spending priorities. In consultation with stakeholders, the strategy should focus on encouraging those investments that will increase productivity and innovation, encourage growth of firms and diversify exports.58 This strategy should be formalized in an agreement between the two governments on how to attract and retain manufacturing investments.

» As part of this strategy, the federal government should establish a fund to attract new assembly mandates in areas consistent with Ontario's value proposition and to level the playing field with other jurisdictions bidding for similar mandates.

» As part of this strategy, governments and the private sector need to leverage and align their resources to improve the export capacity of SMEs (some examples include: creating a one-window online portal for SMEs to access government export information and support, undertaking reverse trade missions focused on emerging markets, and making export insurance more readily available for small deals).

Enhancing Ontario's comparative advantages in manufacturing

Ontario is a good place to invest in manufacturing. In particular, for those firms that require highly skilled labour and/or firms producing inputs at the higher end of the GVC, Ontario is an exceptionally attractive place to invest. Ontario's value proposition to existing and potential investors must be protected and continuously enhanced.

Competitive tax system

Federal and provincial changes to the tax system over the past decade have given Ontario a very competitive tax system. Governments can continue to build on this strength.

» The corporate tax structure currently favours small business activity but creates a distortionary incentive for Ontario's businesses to stay small ('taxation wall').[59] Preferential tax rates for small businesses should be phased out.

» Increase the incentives within the tax system to make productivity enhancing investments in skills, ICT and M&E, so long as these incentives do not unduly distort behavior in other areas. Reforms to the corporate tax rate structure to encourage capital investments could include:

»» Encourage more investment by providing firms with the ability to expense capital investments up to a certain limit.[60] The JPC suggests that this should be done by increasing the existing accelerated capital cost allowance (ACCA) rate to 100 per cent for a limited time and consider making the current 50 per cent rate permanent.

»» Adopting capital gains tax relief for firms that convert into a publicly-owned entity.

»» Introducing a formal capital gains deferral account to reduce the existing 'lock-in' effect of capital gains taxes and therefore allow firms to modernize their existing capital assets on a deferral basis.

Ideal geographic location

The federal and provincial governments have shown real leadership by investing in the Detroit River International Crossing. The federal government in particular was willing to expend political capital to ensure that the flow of goods across the Canada-US border at Windsor was improved. Continued vigilance around border stickiness has been important. But more can be done.

Manufacturers from across Quebec and Ontario regularly highlight congestion, particularly in the Greater Toronto Area, as a significant obstacle to delivering their goods to clients in a timely and predictable manner. The impacts of congestion on increased commute times also mean that many employers are having more concerns about getting their employees to work on time and predictably.[61] Unless we act, we are diluting our significant locational competitive advantage.

» The federal government must participate in the creation of a real transit strategy for the GTHA and invest significantly more in this vital infrastructure to facilitate the free movement of goods and people (including workers) and reduce the costs of congestion.

» A more significant investment in infrastructure renewal is needed. Although the Building Canada Fund provides some infrastructure support, it is not enough to address aging infrastructure challenges that threaten Ontario's long-term prosperity. A significant investment in infrastructure would also support crucial economic activity that will need manufactured inputs.

» Federal, provincial and municipal governments should continue to explore opportunities to leverage private capital and innovative financing tools to bring additional funds to the transit and infrastructure tables.

Participation in free trade agreements

Canada's participation in a growing number of international trade agreements is a useful platform from which manufacturers can increase exports. But the trade agreements are not enough. Firms must seek out more

trading opportunities globally and reduce their dependency on the United States. Increased competitive pressure will be helpful for Canadian manufacturers.

» The federal government should continue ongoing trade negotiations with regions such as the EU, India, China and Korea as well as the Trans-Pacific Partnership (TPP) and work to finalize these.

» Expand access to capital for small firms through initiatives such as the partnership between the Export Development Corporation and Canadian Manufacturers and Exporters (CME) to offer smaller manufacturing firms a credit insurance policy. Allowing small firms to access the kind of insurance that large firms are offered should increase the protection against non-payments by clients, minimize risk, increase working capital and encourage more SMEs to explore exporting to new markets. This new initiative should be monitored and evaluated to see how it can be improved or expanded.

» As part of ongoing Canadian-US regulatory cooperation initiatives (*Beyond the Border* and *the Regulatory Cooperation Council*), create a new Provincial-State Regulatory Caucus to help contribute to public understanding of why differences in regulation matter and to help focus efforts on areas where harmonization at the sub-national level are possible. Underneath the umbrella of these federal processes, state-provincial work could be focused on manufacturing standards.

» A number of ongoing efforts are important and need to be undertaken with increased urgency:

»» The federal government should modernize and clarify the intent of the Net Benefit Test in the Investment Canada Act and its relevant considerations. This should include clarifying guidelines around the participation of State-Owned Enterprise in investments in Canada.

»» Continue to lower inter-provincial trade barriers, increase labour mobility and improve credential-recognition to address issues of skill shortages in some manufacturing industries.

»» Encourage partnerships between Central Canadian manufacturers and those with demands for products in the resource sector.

Supportive economic ecosystem

Manufacturers in Ontario have a supportive economic ecosystem, which includes professional and business service firms, access to capital, a legacy of manufacturing expertise and many successful clusters in a wide array of sub-sectors. Manufacturers looking for ICT support, asset management advice, a government that understands the importance of manufacturing, or potential partners in most sub-sectors can find them in Ontario. Additional steps could also be taken to further improve the current ecosystem.

The federal and Ontario governments should re-examine business development programs with an eye towards realignment and collaboration. This could be undertaken through a process of both vertical and horizontal program review within and between both governments. Outcomes would include strategically supporting successful sectors and clusters, adopting place-based economic and community development strategies and investing political capital in supporting anchor firms.[63]

If this alignment moves forward, it will be possible to streamline business financing resources into one central source. Although headway has been made in creating an online portal for advisory services and sources of information and financing support, these resources are fragmented and lack visibility. Multi-level government collaboration is critical to streamline all resources into one recognizable outlet and brand, similar to the successful transactional service delivery, Service Canada and Service Ontario.

Create an innovation hub similar to the Boston Bolt, which provides a launch pad for innovative manufacturing hardware start-ups. The facility would help address scalability issues for manufacturing start-ups to commercialize their products by providing 24/7 access to in-house prototyping equipment and capital. This facility would likely be able to be self-financing after an initial start-up phase, which could be funded by the recently announced federal Advanced Manufacturing Fund.

Skilled workforce

Ontario's workforce is a huge comparative advantage. Skilled labour will be crucial to success in the next generation of manufacturing. Workers will need sophisticated training. We have a great foundation, but we need to do more.

» Ontario manufacturers pay high Employment Insurance premiums to support job training programs. A significant majority of these funds go to support workers outside Ontario rather than inside. The most important change that governments can implement to improve access to skilled labour in Ontario is to develop a real national human capital strategy that would include a reduction in EI premiums directed toward supporting training, accompanied by a revenue neutral increase in general revenue funding for training for those who are not eligible for EI. This would significantly increase the available pool of funds for Ontario manufacturers. Increased funding for training from general revenues could be paid for by a payroll tax supplement that replaces part of the employer's EI premium for training.

» Vocational and workplace training should be encouraged through the use of "contract clauses". These contractual agreements provide commitments from employees that they would return to the same firm following employer-funded training—or reimburse the employer for the training. This would help minimize uncertainty and risk for employers who are apprehensive about investing in employee training.

» The federal government should develop credible alternatives to the Canada Job Grant proposal that would ensure appropriate skills training for Canadians and engage employers. Some potential alternatives include a federal training tax credit or a skills grant.

» The Ontario Government should work with the private sector to promote entrepreneurship in the education system. This could include building an entrepreneurship focus in the Specialist High Skills Major program curricula in Ontario, providing all teachers and guidance counselors with an entrepreneur "toolkit" to assist youth in their entrepreneurial ideas and aspirations, and including an entrepreneurship section in the Grade 10 Career Studies course.[64]

» Private sector firms and colleges should collaborate more closely on particular skills. Experiential learning is important for equipping students with up-to-date workplace skills and business must play a bigger role in offering more co-ops, work placements and apprenticeships for Ontario students.[65] This should include training students on computer assisted fabrication processes and preparing them for the "Internet of Things" movement and other cyber-physical systems.

» The Ontario government should place more emphasis on skilled trades in a variety of ways, including for example, by increasing the effectiveness of local Business-Education Councils so that students better understand the skilled trades, by reducing journeyperson-to-apprentice ratios, and by increasing the number of compulsory trades.66

» The federal government should simplify access to information on job candidates for employers by providing a 'one-stop-shop' service. This could involve building out from the EI Universal Job Board and making it more widely available. This would help smaller manufacturing firms who often lack the capacity or resources to draw the necessary talent to be competitive in the industry.

» The federal government should hasten existing efforts to fast-track credential assessments as part of the immigration process (including instructing new immigrants of these processes prior to their departure from their home countries); and harmonize certification of professions vital to manufacturing across Canada and US jurisdictions.

Existing cost advantages

Ontario's labour costs are very competitive at higher ends of the value chain and in high productivity sub-sectors—areas we have argued are key to Ontario's manufacturing future. These competitive labour costs must be maintained.

Debates about the cost of energy in Ontario have become highly political. We will not weigh in on those debates. What we would highlight, however, is that costs of production could be brought down if manufacturers use less energy. Our research has shown that Ontario manufacturers are less energy-efficient than our peer jurisdictions. Policy must encourage this to change.

» Governments should increase supports for energy efficiency investments using the tax system or alternative vehicles, such as Green Bonds.

» Canada could boost energy efficiency through the adoption of a carbon rebate. This rebate would take a two-pronged approach, combining the UK carbon model and the accelerated depreciation mechanism similar to the Dutch VAMIL or EIA approach. Those firms that were able to bring down their carbon and energy usage would see a reduction in their tax bill. Unlike a carbon tax, where those who use energy inefficiently must pay more, a carbon rebate allows those who increase their efficiency to pay less.

Ontario's foundational advantages

Canada is, simply put, a very attractive place to invest. Canada has an enormously attractive value proposition tied to its foundational advantages, such as stability, prosperity and quality of life. Unlike in the previous section, where we outlined many detailed policy recommendations, this section contains few specific recommendations. What we do, however, is highlight the many attractive qualities that Canada offers current and potential investors in an effort to remind readers and policy-makers that these should not be discarded.

Economic and political stability

Canada's position on the World Bank's global 'Ease of Doing Business' indicators has generally been among the best in the world. In recent years, our standing has been falling. In addition, for the past five years Canada has been slipping in the global corruption standing. In the recently published Corruption Perception Index, Canada fell from 6th place to 10th place, displaying its worst ranking in five years. This is a serious problem and governments should increase their efforts to ensure that Canada's reputation as a safe, trustworthy, and predictable place in which to invest does not erode further.

Governments should continue their focus on initiatives to improve regulatory predictability and certainty (e.g., increased transparency regarding cost-benefit analysis of regulatory proposals, predictable enactment dates for regulations), and also renew efforts to identify areas for regulatory harmonization and reduction of overlap and duplication, both from a regulatory development and enforcement perspective.

Canada should continue efforts to become a leading jurisdiction where companies can create and control their own IP—and know that protections will be enforced.

High regulatory and safety standards

Although regulatory standards are sometimes a source of complaint for some manufacturers, they also provide an enormous brand advantage for others. The Canada brand is meaningful and valuable. Canada has an enormous opportunity to take advantage of our reputation and offer goods to the world. To an emerging global middle class looking to purchase new processed food stuffs or other products, "Canada" is a safe, trustworthy, healthy brand. The consequences of losing Canada's reputation for very high environmental and food-safety standards would be dire. And reputation, once lost, is difficult to regain.

Some steps to protect our brand and enhance our reputation could include:

» Developing world leading health or safety standards for a variety of products.

» Strengthening rather than weaken environmental, worker and consumer protections—and marketing these strengthened standards as comparative advantages.

» Canadian firms applying higher safety and health standards across their assembly plants, including those in countries where protections are weaker.

High quality of life

For an investor thinking of establishing a new sophisticated manufacturing operation in a community, Ontario communities offer a great deal. For European or Asian firms, relocating managerial and executive personnel to Ontario—as opposed to many of our competitors—is very appealing.

Safe communities, access to health care, good quality public schools, liveable cities, breathable air, diverse populations—these should not be underestimated when encouraging a firm to locate a new operation in Ontario. As such, investments in public transit, public safety, education and other social services are in fact investments in our economic value proposition.

Diversity and diaspora networks

As we know, the global economy is undergoing a re-balancing, with the rise of emerging economies and new structural economic challenges in OECD countries, including Canada. Diaspora networks–that is, international communities of shared identity–provide Canada with an enormous potential to pivot toward emerging economies in our trade relations.

Diaspora networks are playing a larger role in the global economy. Recognizing and acting on this trend should be part of a thoughtful policy response to the shifts in the manufacturing sector. Given Canada's successful history with diversity and accommodation and the high concentration of immigrants in Ontario, the province is well-placed to become a centre for global manufacturing.

The policy agenda is clear. Ontario needs more economic class immigrants, quicker recognition of skills and credentials, increasing the number of international students and more bridge training. The private sector needs to do a better job leveraging diverse talent. The Mowat Centre outlined actions that governments and the private sector could take in an earlier publication and we will not repeat that agenda here.[67] But what should be highlighted is that Canada is a Diaspora Nation and this is an advantage in the new world of global manufacturing.

Ontario does in fact have a highly attractive value proposition to offer existing and potential manufacturers, and it has everything necessary to strengthen its manufacturing sector.

8

Conclusion

The manufacturing sector in Ontario is at an important crossroads. There is great turmoil in the global manufacturing sector and many Ontario communities and firms have experienced the discomfort of this profound change. Many of the province's traditional advantages are gone. Some public commentary has suggested that manufacturing is either not important or that Ontario cannot compete. Our research suggests neither of these two speculations is well-founded. Ontario has many comparative advantages and manufacturing produces more positive spillovers for the rest of the economy than other sectors.

The sector is changing—and needs to continue to change if it is going to continue to be a source of prosperity for the country and economic opportunity for individual Canadians. Simply retaining what we have or protecting firms and sectors that cannot compete is not a pathway to success. But neither is abandoning manufacturing an attractive option.

Governments and the private sector need to appreciate, invest in, and steward our comparative advantages. A sustained, strategic focus by government is necessary. Ontario has a great deal to offer—including a competitive tax environment and a skilled workforce—but these are not enough. This paper has mapped out what governments and the private sector need to do to ensure that the manufacturing sector continues to provide prosperity and economic opportunity to many communities and people in Ontario.

Federal leadership and engagement is necessary. The Ontario manufacturing sector represents 46 per cent of Canadian manufacturing. This isn't just an Ontario issue—it has national implications, and successive federal governments have failed to develop an advanced manufacturing strategy for the country.

The goals for government are clear: increase productivity and innovation within the sector so that firms can grow larger and be more successful global exporters. Encouraging investments in Machinery & Equipment, ICT, Research & Development and job training is crucial. These actions must be taken while protecting and building on Ontario's attractive value proposition and many comparative advantages.

We are at a moment of historic global change and Ontario manufacturers are facing an existential threat. For many, their traditional business models have been made obsolete. For many, their traditional advantages have eroded. They are beginning to pivot towards the world. Most are adapting but it is part of government's job to help support this historic realignment. This document has outlined how such strategic support can be deployed.

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Technical Appendix

Productivity

Manufacturing sub-industries categories were sourced from the North American Industry Classification System (NAICS) at the three-digit level. Ontario figures are compared with its North American peer jurisdictions, where regions selected are based on the work applied from the Institute for Competitiveness & Prosperity (2002). These regions are chosen as they present a relatively robust benchmark with Ontario—they closely resemble Ontario's size (population of over six million or at least half of Ontario's population size), resource endowment and economic mix. Therefore, the North American peer average is defined as the average (or the median when otherwise stated) of the 15 peer states: California, Florida, Georgia, Illinois, Indiana, Massachusetts, Michigan, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Texas, Virginia and Quebec.

Productivity, formally known as labour productivity, is calculated as real GDP over total hours worked. Total hours worked is computed as total employment times average annual hours worked. Due to data limitations and for calculations to remain comparable across regions, total employment includes all full-time and part-time employment. Annual average hours worked is calculated based on full-time work only to mitigate significant variability from part-time employment.

Aggregate level data for Canadian GDP, employment and total hours worked were derived from Statistics Canada CANSIM Tables 383-0010 and 379-0025. Manufacturing sub-sector labour statistics at the provincial level were calculated using the Labour Force Survey microdata.

US Gross State Product was retrieved from US Bureau of Economic Analysis, and converted to 2002 chained Canadian dollars using a purchasing power parity (PPP) rate, sourced from Statistics Canada CANSIM Table 380-0057. Labour statistics at the industry and state level were calculated using the Integrated Public Use Microdata Series (IPUMS), Current Population Survey. Census codes from IPUMS were concorded with 3-digit NAICS codes. To make the data comparable with Canadian figures, labour statistics were modified to ensure that labour force was defined as those aged 15 years and over and average hours worked were calculated for those employed and working full-time only.

German state and industry level data was retrieved from the Statistical Offices of the Federation and the Länder. GDP was deflated and converted to real 2002 CAD dollars using OECD PPPs to maintain comparability with Canadian data.

Productivity groups

Manufacturing industries at the three-digit NAICS were ranked and categorized into three classes—High, Medium and Low Productivity Industry Groups. The rationale behind creating this classification of sub-industries is to shed light on any distinctive characteristics that may converge within each category as well as to explore possible tailored policy approaches to these specific groups. These sub-groups were created in two ways. Firstly, US and Canada overall productivity numbers were each calculated over a range of years, where data was available, ranging between 2004 and 2011. Average productivities were calculated across all years, then ranked and divided into tertiles. To add greater robustness to the rankings, a second comparison of productivity levels were calculated through an international analysis, comparing data from US, Canada, Australia and Germany where data was available. The average productivity of all international jurisdictions was calculated and ranked accordingly. Despite slight differences in the rankings within each tertile, the overall groupings among the three tertiles remained the same. Although other countries were considered for a more robust international analysis such as the UK and France, data limitations prevented further analysis.

The final three Productivity Groups and their individual sub-industries are as follows:

NAICS CODE	DESCRIPTION
HIGH PRODUCTIVITY	
324	Petroleum and coal products
325	Chemical products
334	Computer and electronic products
331	Primary metals
336	Transportation Equipment Manufacturing
311	Food and beverage and tobacco products
MEDIUM PRODUCTIVITY	
322	Paper products
339	Miscellaneous manufacturing
333	Machinery
335	Electrical equipment, appliances, and components
327	Non-metallic mineral products
326	Plastics and rubber products
LOW PRODUCTIVITY	
332	Fabricated metal products
321	Wood products
323	Printing and related support activities
313	Textile mills and textile product mills
337	Furniture and related products
315	Apparel and leather and allied products

Unit labour cost

In addition to the productivity sources used, labour compensation figures were retrieved from the US Bureau of Economic Analysis and CANSIM Table 383-0022 for US and Canadian data respectively. Since labour compensation is issued in current dollars, all compensation figures were converted to real 2010 Canadian dollars using CPI and PPP rates from Statistics Canada

Unit labour costs are calculated as total labour compensation over total GDP, with both variables converted to 2002 chained dollars.

Capital cost

In this paper, capital was defined as the physical assets used in the manufacturing process. These physical assets include building assets, engineering infrastructure and machinery and equipment (M&E). However, given a lack of intensity gap in engineering structures and buildings between the US and Canada, a focus was placed on mainly machinery & equipment, and specifically, on information and communications technology M&E. Much of the analysis was conducted at a national level due to data limitations at a provincial and sub-sector level. The majority of data was generally sourced from the CSLS Database of Information and Communication Technology (ICT) Investment and Capital Stock Trends. Other sources included US Census Bureau 2011 Information and Communication Technology Survey, US Bureau of Economic Analysis (for data on Investment in Private Equipment and Software by Industry) and Statistics Canada CANSIM Tables 031-0003, 327-0042, 029-0005 and 031-0004.

Sub-industry analysis utilized data on capital expenditures on machinery and equipment (CANSIM Table 029-0005), and excludes tobacco and leather product manufacturing in the calculation of Productivity Groups due to data limitations. The breakdown of Ontario's capital expenditure on M&E by Productivity Group was presented as a percentage of output (GDP was calculated using CANSIM Tables 379-0025 and 379-0030); all variables were in current dollars.

Capital intensity was measured as total M&E investments per worker. Capital output ratios were calculated as capital expenditures on M&E as a percentage of output. Implicit price deflators were used as proxies to assess the magnitude of price changes in ICT investments between Canada and the US. These were measured by the price deflators of ICT investment, applying the same methodology used in CSLS (2005) *What explains the Canada-US ICT investment intensity gap?*

Energy efficiency

Energy use by energy source data for Ontario was collected from Natural Resources Canada (NRCAN). Real value added at the 3-digit NAICS level was obtained from Statistics Canada. For some sub-industries, NRCAN provides data only at the national level. In these cases, energy use was proxied by taking Ontario's share of real value added for that particular sub-industry in 2010 and multiplying it with the energy use data for natural gas and electricity, respectively.

A similar approach was chosen in calculating energy use for sub-industries in U.S. peer jurisdictions. Energy use by energy source data was obtained from the manufacturing energy consumption survey (MECS) conducted by the U.S. Energy Information Administration (EIA). Real value added data for manufacturing sub-industries by U.S. state was provided by the Bureau of Economic Analysis. Subsequently, energy use for each sub-industry for U.S. peers was proxied by calculating the corresponding shares of the consumption of natural gas and electricity.

Data on energy use and real value added at the 3-digit NAICS level for German peer jurisdictions were obtained from the Landesämter für Statistik for the jurisdictions of Baden-Württemberg, Bayern, Hessen and Nordrhein-Westfalen.

Subsequently, all units of energy usage were recalculated to kilowatt-hours to be comparable across jurisdictions. Real value added numbers in manufacturing for all jurisdictions were recalculated to purchasing power parity US$ using Penn World Table data for 2010.

Electricity prices for industrial use for Ontario were proxied as follows. Wholesale prices for industrial customers were obtained from the Independent Electricity System Operator (IESO). To that we added the IESO's Global Adjustment. In essence, the Global Adjustment is charged in addition to the regular price to adjust for fixed rates, guarantees and subsidies. In a final step, charges for distribution and transmission were added using data provided by the Association of Major Power Consumers in Ontario (AMPCO). This last step was taken to make prices comparable across international jurisdictions as electricity prices for the U.S. and the EU include transmission and distribution costs.

Electricity prices for U.S. peer jurisdictions were obtained from the U.S. Energy Information Administration's Average Price by State by Provider (EIA-861) table. The dataset provides average industrial prices by state in cents per kilowatthour. This price includes charges for distribution and transmission.

Finally, electricity prices for industrial use in Germany were obtained from Eurostat. These also include charges for transmission and distribution.

Gas prices for all jurisdictions were obtained from the International Energy Agency (IEA) database. IEA reports prices for the consumption of natural gas in the industrial sector in purchasing power parity U.S.$ per MWh.

For comparison, all electricity prices were re-calculated to purchasing power parity U.S.$ expressed in cents per KWh. All prices for natural gas were re-calculated to reflect U.S.$ per KWh at purchasing power parity rates.

To establish cost effectiveness with regard to the consumption of electricity and natural gas, we divided an industry's real value added by the product of electricity/gas usage and the equivalent price.

Regression analysis—drivers of comparative advantage

Theoretical framework

This section provides the direction of possible policy responses to address Ontario's manufacturing sector. It serves as a springboard to help guide researchers towards a broader policy response and generate greater understanding of the inherent factors that are associated with a country's comparative advantage.

A mature economy's comparative advantage in high technology goods is shaped by a robust advanced manufacturing sector that produces high value-added commodities. It signals a highly skilled labour force, strong capital stock and well-developed infrastructure and technology.

The analysis below is based on Braunerhjelm and Thulin's (2008) paper on comparative advantage which vaults from Ricardian trade theory that comparative advantage is formed from differences in the stock of sector-specific production processes and knowledge spillovers (Redding 1999, Braunerhjelm and Thulin, 2008). The analysis expands on existing literature by examining other factors such as inward FDI, education, regulatory quality and institutional effectiveness, and how they play a role in a country's comparative advantage.

Data

The model considers a panel data set which comprises economic indicators for 19 selected OECD countries between the years 1990 and 2011. A focus on the most developed OECD countries were primarily chosen since these countries generally lead the global market in high technology manufacturing production and are associated with established markets and larger production scales (Braunerhjelm and Thulin, 2008). Data was retrieved from various sources including OECD, the World Bank database, Statistics Canada, EuroStat, the US Bureau of Economic Analysis and other national statistical agencies.

The model analyzes the relationship of comparative advantage with various determinants across the sample countries. Comparative advantage (XHT) is measured here as the share of high technology exports (as a percentage of total exports). Developed by the OECD, high technology exports are defined as industry exports with high levels of expenditures on research and development in relation to gross output and value added. This measure provides a good proxy of comparative advantage as it indicates that these exports possess a level of sophistication due to greater value added, the utilization of highly skilled labour, and more innovative practices and processes (Braunerhjelm and Thulin, 2008).

All variables, unless otherwise stated, are expressed as a percentage of GDP. These explanatory variables include:

1. Size (SIZE), measured by a country's GDP as a percentage of total selected OECD countries. This serves as a proxy for market size which is achieved through larger markets and controls for higher comparative advantage achieved from economies of scale in production;
2. R&D expenditure (RD), which represents gross domestic expenditure on R&D for total business enterprise (as a percentage of GDP);
3. Foreign direct investment (FDI), measured as total inward FDI as a percentage of GDP. This variable acts as a proxy that controls for a country's stock of capital. It is lagged by one year to account for length of time for capital and knowledge to diffuse into a country's production processes. It is expressed as total inward FDI as a percentage of GDP;
4. Resource rents (RENT) which controls for a country's endowment of resources, and represents the sum of oil, gas, coal, mineral and forest rents, as a percentage of GDP;
5. Industry size (INDSIZE), which measures for the total size of the production sector as a percentage of GDP. Given that literature reveals a weak relationship between R&D expenditures and high tech manufacturing export, this may in part be explained by the magnitude of the rest of the production sector which absorbs a significant portion of R&D resources (Braunerhjelm and Thulin, 2008). This variable therefore proxies for the size of the sector and controls for R&D intensity taken up by the relatively lower tech production sector.
6. Education (EDUC), which is measured as number of graduates in natural science, engineering, manufacturing and construction as a percentage of total number of OECD graduates. This serves a proxy for all natural science and skilled trades workers and is lagged by two years to account for time spent job search and training on the job;
7. Regulatory quality (REG), a variable produced by the World Bank that enables a broad range of businesses, academics, governmental representatives and other professionals to rank the level of government regulation that promotes private sector growth;
8. Government effectiveness (GOV), which is also produced by the World Bank to reflect the perceptions of the quality of government institutions and their ability to formulate and implement public services

The final modification specification is as follows:

$$XHT_{i,t} = \alpha_{i,t} + \beta_1 FDI_{i,t} + \beta_2 RD_{i,t} + \beta_3 EDUC_{i,t} + \beta_4 REG_{i,t} + \beta_5 GOV_{i,t} + \beta_6 Z_{i,t} + \varepsilon_{i,t}$$

The notations i and t represent country and time respectively. Z denotes the control variables country size (SIZE), production-sector industry size (INDSIZE), and total resource rents (RENT). All variables are robust against multicollinearity (Table 1). The model was regressed using the Newey-West estimator to overcome heteroskedasticity and serial correlation in the model residuals.

TABLE 1
Correlation Table

	XHT	SIZE	FDI	RD	REG	GOVEFF	RENT	INDSIZE	EDUC
XHT	1								
SIZE	0.4858	1							
FDI	0.1107	-0.1941	1						
RD	0.5026	0.2156	-0.0077	1					
REG	0.2318	-0.0867	0.1659	0.2599	1				
GOVEFF	0.1894	-0.1962	0.1804	0.4478	0.7973	1			
RENT	-0.4618	-0.1529	-0.0718	-0.2231	0.1253	0.2729	1		
INDSIZE	-0.3731	-0.303	-0.1498	0.0301	-0.0484	0.1457	0.5672	1	
EDUC	0.5241	0.9266	-0.2401	0.2134	-0.2072	-0.2657	-0.2116	-0.3477	1

Results and discussion

Table 2 displays the results of the regression analysis. Models 1 to 3 regressed each determinant of comparative advantage separately. Model 4 regressed all determinants including all control variables, and scores a higher goodness of fit. Our final results are derived from Model 5, as the model was regressed using the Newey-West estimator with one lag to overcome issues of heteroskedasticity and serial correlation in the model residuals. The resulting standard errors are more robust and appear to best reflect the array of policy instruments inherent in explaining comparative advantage in high technology manufacturing. Though modelling fixed effects were considered in the analysis, the final model utilized the Newey-West estimator instead to account for any omitted variable bias.

TABLE 2
Regression results

	MODEL 1	MODEL 2	MODEL 3	MODEL 4
R&D	8.194*** (0.52)			2.086* (1.76)
FDI		0.308** (0.10)		0.255** (3.01)
REG			0.011 (0.01)	0.022* (1.73)
GOVEFF			0.015 (0.01)	0.020 (1.49)
RENT				-0.008*** (-3.74)
INDSIZE				0.001 (0.48)
EDUC				0.738*** (3.59)
SIZE				-0.155 (-0.93)
CONSTANT	0.054*** (0.01)	0.155*** (0.01)	0.160*** -0.01	0.075* (1.84)
R-SQUARED	0.39	0.02	0.03	-
NO OF OBSERVATIONS	360	399	303	168

Note: Standard errors in parentheses. *, ** and *** represent the statistical significance at the 10, 5 and 1 percent level respectively.

The results show all variable coefficients illustrate the same sign as initially hypothesized. R&D expenditure, inward FDI, education and regulatory quality have a positive and statistically significant impact on a country's comparative advantage in high technology exports. Only government effectiveness appears to be statistically insignificant. The findings also indicate that high resource endowments, reflected in resource rents, have a negative influence and imply some degree of Dutch disease effects.

The biggest impacts on comparative advantage appear to be from R&D expenditure and education. A one percentage point increase in R&D expenditure is associated with 2.086 percentage point increase in high technology export share. Similarly, a percentage point increase in a country's share of graduates as a total of OECD graduates translate to a 0.738 percentage point increase in XHT. This is indicative of higher shares of skilled trades, engineering and natural science labour on high technology production and exports. Institutional factors, as measured as government effectiveness and efficacy of regulation to foster private sector development, play an important role in promoting comparative advantage.

List of Figures

Endnotes

1 See Van Assche (2012) and Sturgeon et al. (2008).

2 For an overview of the different perspectives see Bhagwati (2011) and Chang (2011).

3 Note: For easier readability, all ratios were multiplied by 100.

4 The list of comparable jurisdictions were applied from the research from the Institute for Competitiveness & Prosperity (2002) Closing the prosperity gap, First Annual Report, November 2002, p. 15

5 Manufacturing-intensity in these states is measured by manufacturing employment share over 10 percent of total employment.

6 For additional explanations derived from demographic developments see Pilat et al. (2006). For explanations based on productivity differentials see Woelfl (2005) and Baldwin and Macdonald (2009).

7 See Bernard (2009).

8 For empirical literature on tariff reductions see Beaulieu (2000) and Larochelle-Cote (2007). Bridgeman (2012) points out that multilateral trade agreements achieved in the WTO and the General Agreement on Tariffs and Trade (GATT) negotiations led to a sharp drop in average tariff rates since the 1950s, especially with regard to manufactures. Hummels (2007) and Hillberry study the effects of lower transportation cost on international trade.

9 For an in-depth discussion on the rise of global value chains see Grossman and Rossi-Hansberg (2008), Grossman and Rossi-Hansberg (2008).

10 In this context, Mandel (2011) points to the consequences of the rise in GVCs with respect to measuring a country's competitiveness. Common export-based measures of competitiveness are misleading in an environment where production is broken down into different tasks and locations. For instance, Koopman, Wang and Wei (2008) find that when taking into account the value of input factors used in the production of commodities in China, the country's own share in total export value is only about 50 percent. For Canada, Johnson and Noguera (2012) estimate the domestic content share of exports at about 70 percent. In other words, Canada produces around 70 percent of the total value of its exports.

11 See Baldwin and Macdonald 2009 and Baldwin and Yan 2010.

12 See Gordon 2012, OECD 2012, Beine et al. (2012), and Macdonald (2007) for differing opinions on this issue.

13 As Boyce and Emery (2011) state, however, a rise in the resource sector does not inevitably lead to a permanent damage to the economy.

14 Productivity levels were evaluated by comparing Ontario manufacturing sub-industries with their equivalents from North American peer jurisdictions. Applying the approach used by the Institute for Competitiveness & Prosperity (2002), these jurisdictions are a fairly robust benchmark with Ontario, as they closely resemble Ontario's size (i.e., a population of over six million or at least half of Ontario's population size), resource endowment and economic mix. These jurisdictions include Quebec, California, Florida, Georgia, Illinois, Indiana, Massachusetts, Michigan, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Texas, Virginia. Sourced from the Institute for Competitiveness & Prosperity (2002) *Closing the prosperity gap*, First Annual Report, November 2002, p. 15

15 These sub-industries include clay, glass, cement, lime and other non-metallic product manufacturing.

16 Figures are in real 2010 Canadian dollars.

17 See TD Economics (2007), Conference Board of Canada (2011) and Institute for Competitiveness & Prosperity (2012a).

18 See Baldwin et al. (2008) and Rodriguez and Sargent (2001).

19 See Sharpe (2005).

20 TD Economics (2007) "Canadian companies not taking advantage of investment opportunities," *Special Report*, August 14, 2007

21 Calculated as the average annual growth rate of new investments in M&E. Data sourced from CANSIM Table 031-0002.

22 Sharpe and De Avillez (2010)

23 Ontario Ministry of Finance (2013) *A Prosperous & Fair Ontario*, 2013 Ontario Budget, p. 257, available online: http://www.fin.gov.on.ca/en/budget/ontariobudgets/2013/papers_all.pdf

24 Deloitte (2012) The future of productivity, available online: http://www.deloitte.com/assets/Dcom-Canada/Local%20Assets/Documents/Insights/ca_en_future_of_productivity_2013_report.pdf

25 Atkinson and Ezell (2012).

26 See Reuters (2014).

27 See Autio (2007). Though high growth can also be defined by the degree of profitability of a firm, this report focuses on employment growth as a better measure of social direct and indirect benefits to the economy.

28 Baldwin (1997), Baldwin and Sabourin (1998) and Leung, Meh and Terajima (2008).

29 Authors calculations based on data from Statistics Canada, CANSIM Table 281-0041.

30 Industry Canada defines a small business based on the number of employees, with goods-producing firms having fewer than 100 employees, while service-producing businesses are "small" if there are fewer than 50 employers (Industry Canada, 2012).

31 Industry Canada (2011) *Survey on Financing and Growth of Small and Medium Enterprises*

32 OECD (2007) Eurostat-OECD *Manual on Business Demography Statistics*, p. 61, available online: http://www.oecd.org/std/business-stats/eurostat-oecdmanualonbusinessdemographystatistics.htm

33 Calculated based on 2006 data sourced from Statistics Canada, Small Business and Special Surveys Division.

34 See: Costa (1997) and Seens (2013) ; Note: This figure reflects Canadian manufacturing growth, not Ontario's due to data limitations.

35 This measure presents a better indicator of success than pure exit rates since exit rates do not take into account the entrance of new firms. In fact, the number of firms entering the industry is highly correlated with number of firms exiting the industry.

36 Data based on the second-year survival rates from OECD (2012) *Entrepreneurship at a Glance 2012*

37 Authors' calculations based on Statistics Canada CANSIM Table 177-0006.

38 Guillemette (2004).

39 Institute for Competitiveness & Prosperity (2012b).

40 Wälde and Wood (2004), IMF (2000), Connolly (1997), Spence and Hlatshwayo (2011) and Baldwin and Gu (2004).

41 See Osvey, D. (2012) "Will Canadian business heed Mark Carney's export diversification message?" in: Financial Post August 27, 2012. Osvey lists market volatility, the European crisis and trade barriers as major reasons why exporters fear risk of diversification outweigh the ROI potential.

42 Authors' calculation based on data from Statistics Canada, CANSIM Table 386-0003.

43 See Hejazi (2010).

44 See Hejazi and Safarian (1999) and van Pottelsberghe de la Potterie and Lichtenberg (2001).

45 See Beckstead and Brown (2006) and Baldwin and Brown (2005).

46 Authors' calculation based on data from Statistics Canada, CANSIM Table 376-0052.

47 See Tyson (2012).

48 2010 was the latest year for which provincial data was available at time of writing.

49 See Baldwin et al. (2000) and Kuittinen (2007).

50 See OECD Oslo Manual (2005) and Expert Panel Report (2011).

51 See Chui et al. (2010) and Nikolaus (2013).

52 More information available online: http://archive.georgebrown.ca:8080/handle/10299/286; http://www.conii.ca/news/latest-news/161.html

53 See Expert Panel Report (2011: 5-14). More recently, the results presented by Ontario's Jobs and Prosperity Council confirmed these findings.

54 According to Statistics Canada, production workers include: employees engaged in manufacturing (processing and/or assembling); logging and forestry support; packing, handling, warehousing; repair and maintenance, janitorial; watchmen; foremen doing work similar to their employees; erection/installation by own business unit when an extension of the manufacturing operations. Non-production workers include: employees designated as executives, administrators and office staff; sales staff; food service staff; as well as, when work is chargeable to fixed asset accounts, building construction and major renovation staff and machinery and equipment repair staff.

55 See Gylfason (2001) and Braunerhjelm and Thulin (2008).

56 Total OECD GDP excludes Chile, Israel, Slovak Republic and Slovenia due to data limitations.

57 Braunerhjelm and Thulin (2008).

58 Jobs and Prosperity Council 2012.

59 ICP 2012.

60 Chen and Mintz 2011

61 Toronto Region Board of Trade 2013

62 Assaf and McGillis 2013

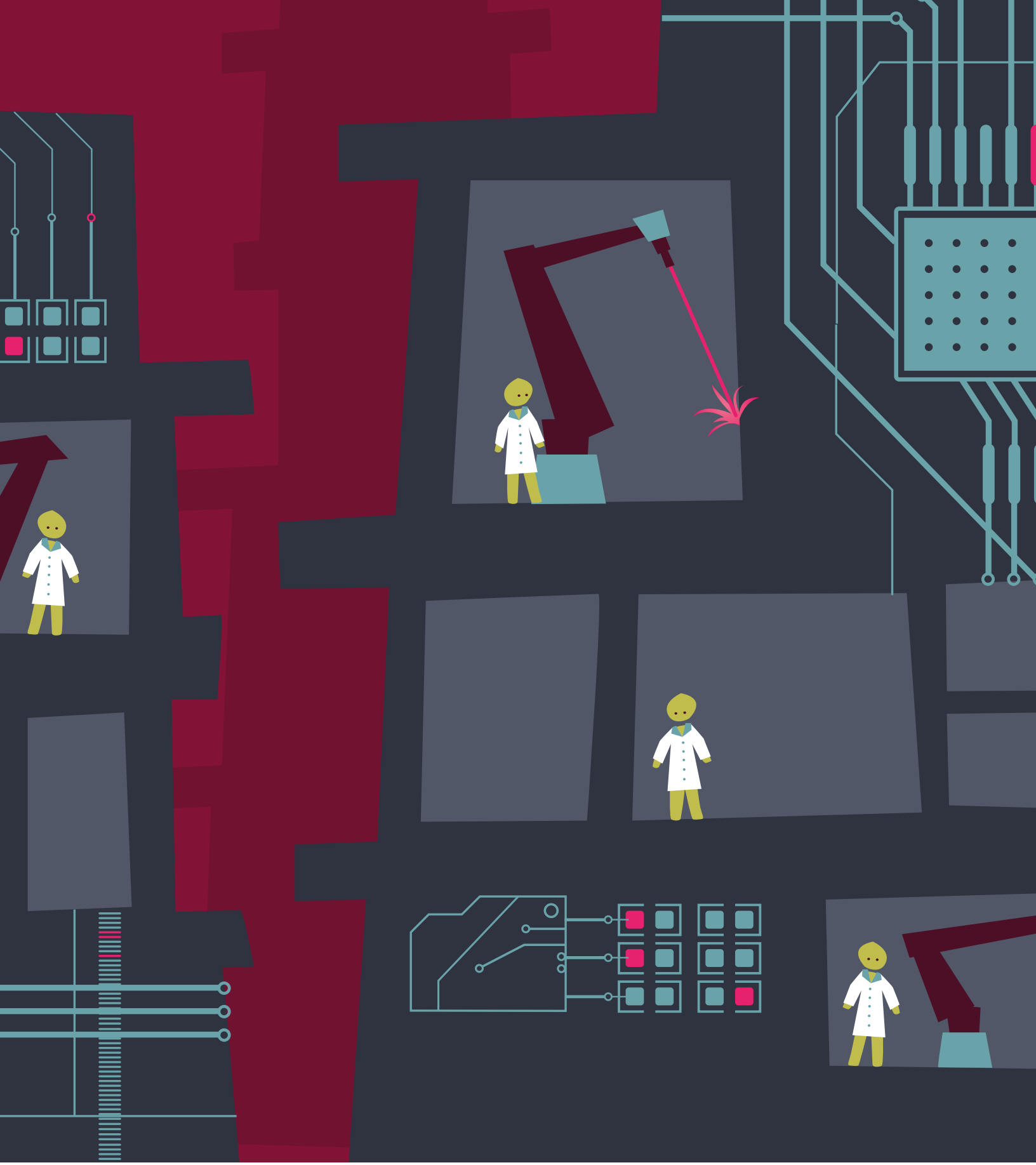
63 Johal et al. 2013; Bradford and Wolfe 2010

64 Jobs and Prosperity Council 2012.

65 Jobs and Prosperity Council 2012

66 Jobs and Prosperity Council 2012, Institute for Competitiveness and Prosperity 2013

67 Tan and Bitran 2013



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