

Producing Black Gold

Understanding the Oil Sands as Part of
Manufacturing in Canada

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Table of Contents

Executive Summary.....	1
Sommaire	2
Introduction.....	3
What is Manufacturing?	6
What is Unique About Manufacturing?	7
Case study: Are the Oil Sands Mining or Manufacturing?.....	10
What Would be the Impact of Classifying the Oil sands as Manufacturing?.....	13
Conclusion	15
About the Author.....	16
References	17
Endnotes	19

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Table of contents: An electric shovel at the Fort Hills site. Suncor Energy Inc. photo.

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Executive Summary

Canada's manufacturing sector, particularly its size and health, has always been intensely interesting to policy-makers and the public. A lively debate took place after its decline beginning in 2003, which gave rise to arguments that Canada was victim to the so-called "Dutch Disease," where a booming resource sector hampers manufacturing because it leads to a higher exchange rate. In this narrative, the growth in the oil sands had a negative impact on Canada's manufacturing sector. However, we rarely debate what is meant by manufacturing? What industries are included and why?

Classification of economic activity by industry is fundamental to understanding the process of economic growth and the foundation of our prosperity. Traditionally, we separate industries into three areas: primary, secondary, and tertiary sectors. Primary industries are associated with extractive natural resources, such as agriculture or mining. Secondary industries are found in manufacturing and construction. Tertiary industries entail a wide range of consumer, business, and government services. It is also well-accepted that economies develop in stages – from primary industries in natural resources to secondary manufacturing industries to the tertiary services industry.

Debating what is manufacturing is not simply a matter of semantics. There has been a long-standing policy bias in favour of manufacturing. In Canada, manufacturing has long received preferential tariff and tax treatment in the belief that growth in this sector brings extended benefits to our economy. Yet today's technological change is blurring the delineation between industries. Manufacturing is evolving into a cloud-based service, as goods from smart phones to autos are now constantly being updated with services embedded in their computer programs. Some firms are classified as manufacturing even if they do not operate a factory or produce a good. In contrast, according to Statistics Canada, all mining activity is classified as being part of the primary industry of mining. Only separate free-standing refining facilities are considered manufacturing. These are meant to refine the product, which entails

changing them from their natural state to be useful to humans.

Yet things get more complicated when it comes to the oil sands, which upgrade their product in complex ways but are still being lumped into mining rather than manufacturing. However, oil sands output does not follow the so-called "rip and ship" model of extracting (i.e., ripping resources out of the ground and shipping them without processing). Oil sands production involves processing raw oil sand ore into bitumen, and some bitumen is upgraded to produce both intermediary and final products. These are then sent to refineries to be converted into a variety of petroleum products. It is arbitrary and debatable to maintain that upgrading oil sand to bitumen or heavy oil is not manufacturing, but refining them in these plants is.

“*It is arbitrary and debatable to maintain that upgrading oil sand to bitumen or heavy oil is not manufacturing.*”

If the oil sands are treated as manufacturing rather than mining, manufacturing would quickly become a source of growth in Canada's economy. It would magnify the declining trend in mining while making manufacturing more than twice as important as mining. In terms of GDP, with the reclassification in place, mining (excluding the oil sands) shrinks from over \$100 billion before the recession to just \$98.9 billion in 2013. Meanwhile, manufacturing GDP grows from \$207 billion before the recession to a new high of \$219 billion in 2013. The impact is even larger if one looks at volume of GDP. Instead of the manufacturing sector shrinking 9.3 percent in volume over the past decade, it has grown 3.3 percent with the addition of the oil sands' output.

Classifying the oil sands as manufacturing changes much of Canada's recent economic history. Instead of a dubious narrative vilifying the oil sands for boosting the exchange rate and slowing manufacturing, the headline would be

how the oil sands symbolize the successful transition of Canada's manufacturing sector from fading industries such as clothing and furniture to those based on natural resources and capital goods – industries that have proved they can survive a brutal global recession and thrive even in an environment where the Canadian and US dollar are at par.

Sommaire

L'importance et la santé du secteur canadien de la fabrication ont toujours suscité un vif intérêt de la part des décideurs et du grand public. Ainsi, on a débattu avec passion de l'affaiblissement survenu à partir de 2003, en arguant que le Canada était victime du prétendu « mal hollandais », à savoir que l'essor du secteur des ressources nuit à la fabrication, car il mène à une hausse du taux de change. Selon cette vision, l'exploitation croissante des sables bitumineux aurait eu une incidence négative sur le secteur canadien de la fabrication. Or, nous ne discutons que très rarement de ce qu'on entend par « fabrication », des industries qui composent ce secteur et pourquoi.

La classification industrielle des activités économiques est fondamentale pour comprendre le processus de la croissance et le fondement de notre prospérité. Traditionnellement, nous classons les industries dans trois champs d'activités distincts : primaire, secondaire et tertiaire. Le secteur primaire comprend les industries associées à l'extraction des ressources naturelles, comme l'agriculture et l'exploitation minière. Le secteur secondaire comprend la fabrication et la construction. Le secteur tertiaire est composé d'un large éventail d'industries de services de consommation, d'affaire et gouvernementaux. Il est également bien établi que les économies se développent par étapes – elles sont d'abord dominées par les industries primaires axées sur les ressources naturelles, puis par les industries secondaires de transformation et enfin par les industries de services du secteur tertiaire.

Débattre de la définition du secteur manufacturier n'est pas simplement une question de

sémantique. Depuis longtemps, les choix politiques privilégient la fabrication. Au Canada, elle a longtemps bénéficié d'un traitement fiscal et tarifaire préférentiel parce qu'on croyait que son dynamisme apportait des bénéfices supplémentaires à l'ensemble de notre économie. Aujourd'hui pourtant, l'évolution technologique tend à brouiller la démarcation entre les industries. La fabrication est en voie de devenir un service « nuagique » puisque les marchandises – des téléphones intelligents jusqu'aux voitures – sont maintenant mises à niveau en permanence grâce aux services intégrés à leurs programmes informatiques. Certaines entreprises sont considérées comme faisant partie du secteur manufacturier même si elles n'exploitent aucune usine ni ne fabriquent aucun produit. En revanche, selon Statistique Canada, toutes les entreprises engagées de près ou de loin dans l'exploitation minière sont classées dans le secteur primaire. Seules les raffineries séparées et autonomes sont considérées comme des entreprises manufacturières. Elles raffinent un produit, ce qui signifie qu'elles modifient leur état naturel pour être utiles à l'homme.

Or, les choses se compliquent lorsqu'il est question des sables bitumineux, industrie qui transforme la matière par le biais de processus complexes, mais qui est pourtant encore incluse dans le secteur minier plutôt que dans la fabrication. La production des sables bitumineux ne repose pas sur le soi-disant modèle qui consiste simplement à « extraire et expédier » (c.-à-d., l'expédition directe à partir du site minier de ressources n'ayant subi aucun traitement). Le pétrole extrait des sables bitumineux est produit en récupérant sur le site de ces sables bruts un bitume dont une portion est traitée en vue d'être transformée en produits intermédiaires et finaux. Ces produits sont ensuite transportés vers les raffineries afin d'être transformés à leur tour en une variété de produits pétroliers. Il est arbitraire et discutable d'affirmer que la transformation des sables en bitume ou en huile lourde ne constitue pas une étape de fabrication, contrairement au raffinage dans les mêmes usines.

Si les sables bitumineux étaient classés dans la fabrication plutôt que dans l'exploitation minière, la fabrication deviendrait de nouveau rapidement une source de croissance pour

l'économie du Canada. La tendance à la baisse serait renversée et ce secteur doublerait en importance par rapport à l'exploitation minière. Sur le plan du produit intérieur brut (PIB), reclasser l'exploitation des sables bitumineux dans la fabrication ferait baisser la production minière entre le sommet antérieur à la récession et 2013, soit d'un niveau de plus de 100 milliards de dollars à seulement 98,9 milliards de dollars. Parallèlement, le PIB dans la fabrication passerait quant à lui de 207 milliards de dollars à un nouveau sommet de 219 milliards de dollars. L'impact serait encore plus grand en volume. Plutôt que d'enregistrer une baisse de 9,3 pour cent au cours de la décennie écoulée, le secteur manufacturier afficherait dès lors une progression de 3,3 pour cent.

Classer les sables bitumineux dans la fabrication changerait totalement l'histoire économique récente du Canada. En effet, l'exploitation des sables bitumineux serait citée comme un exemple de transition réussie, plutôt que d'être l'objet de récits biaisés qui la démontre en raison de ses prétendues incidences sur le taux de change et le ralentissement de la fabrication. Le secteur manufacturier canadien a prospéré hors des industries en déclin, telles que les vêtements et les meubles, vers les industries intensives en ressources naturelles et en biens d'investissement – des industries qui ont prouvé qu'elles peuvent survivre à une récession mondiale brutale et prospérer même dans un contexte où le dollar canadien et le dollar américain sont à parité.

Introduction

The classification of economic activity by industry has long been fundamental to understanding the process of economic growth and the foundation of our prosperity. One of the oldest and most basic classifications of economic activity separates industries into the primary, secondary, and tertiary sectors. The primary industries are associated with extractive natural resources in agriculture, fishing, forestry, and mining. The secondary sector is mostly manufacturing and construction. The tertiary sector

comprises a wide range of consumer, business, and government services. It is also well-accepted that economies develop in stages, progressing from agriculture and resource extraction through to industrial production and finally to the proliferation of services. This paper uses the oil sands to show how our understanding of the economy changes depending on the classification of its activities.

“ *Debating what is manufacturing is not a word game, but is of vital interest to understanding recent trends in the Canadian economy.* ”

Classification issues matter for both policy-making and the public debates that can drive policy. There has been a long-standing policy bias in favour of manufacturing. Following its emergence in the epoch-changing Industrial Revolution, when the dominance of agriculture was superseded by manufacturing, many still subscribe to what is called “the smokestack theory of economic development” – a theory that posits manufacturing as the basis of sustained economic growth. In the words of historian Michael Bliss, “The growth of manufacturing was evidence of proper national development, growing up. Nations without manufacturing industries could never be mature, whole, or wealthy” (Bliss 1987, 248). This belief is reflected in the many advantages still offered to manufacturing, such as a lower corporate income tax rate.

The size and health of Canada's manufacturing sector has always been intensely interesting to policy-makers and the public. Manufacturing has long received preferential tariff¹ and tax treatment in the belief that growth in this sector brings extended benefits to our economy. The state of manufacturing in Canada and the reasons for its decline after 2003 were the focus of a lively debate about the so-called “Dutch Disease,” where a booming resource sector hampers manufacturing because it leads to a higher exchange rate. However, rarely debated is what

do we mean by manufacturing? What industries are included and why? Debating what is manufacturing is not a word game, but is of vital interest to understanding recent trends in the Canadian economy.

In his 18th century *Tableau Economique*, Francois Quesnay argued that agriculture was the basis of all wealth creation, dismissing the value of industry and trade. Soon after, in 1776, Adam Smith in *The Wealth of Nations* said all wealth ultimately came from the primary and secondary sectors, a disparagement of the tertiary sector (services) that carried over into the 19th century writings of Karl Marx. By the twentieth century, GDP counted the value-added contributions of all three sectors to total income. Even then, a basic and controversial question arose and has never been fully resolved: should government spending represent intermediate inputs and therefore be excluded from GDP? Simon Kuznets, the father of National Accounting, argued vociferously that government spending was an intermediate input. As recently as 1980, James Tobin created a variant of GDP that excluded all defence spending.

“ *The oil sands is only one example of an industry that arguably could be classified as manufacturing.* ”

However, despite centuries of analysis about the contribution of the primary, secondary, and tertiary sectors, the distinction between the three has always been hard to define in theory and difficult to implement in practice. Today's technological change is blurring the delineation between industries even more. Manufacturers increasingly supply a stream of services updated continuously through software embedded in their products. In fact, manufacturing is evolving into a cloud-based service, as goods from smart phones to autos are now constantly being updated with services embedded in their computer programs. Some firms are classified as manufacturing even if they do not operate a factory or produce a good.

Meanwhile, oil sands plants that upgrade their product in complex ways are still being lumped into mining rather than manufacturing. If one uses the model that economic growth progresses from resources to industry to services, the boost to Canada's resource sector from the development of its oil sands may seem to some a step backwards in economic evolution. This perception changes if the oil sands are treated as manufacturing rather than mining. Instead of accepting the erosion of manufacturing as part of the long-term evolution of the economy, manufacturing becomes a source of growth in Canada's economy.

If oil sands output was allocated to manufacturing, the share of factory output in GDP would increase from 10.3 percent to 11.3 percent. Moreover, classifying the oil sands as manufacturing changes much of Canada's recent economic history. Instead of a dubious narrative vilifying the oil sands for boosting the exchange rate and slowing manufacturing, the headline would be how the oil sands symbolize the successful transition of Canada's manufacturing sector from fading industries such as clothing and furniture to those based on natural resources and capital goods – industries that have proved they can survive a brutal global recession and thrive even in an environment where the Canadian and US dollar are at par.

With the growth in output from the oil sands, some analysts became concerned that Canada's manufacturing sector was falling victim to the Dutch Disease. This fear was partly based on the long-standing assumption that manufacturing represented a higher state of economic development than resource extraction, a debatable proposition from the point of view of both income growth and technological innovation. Were the oil sands to be reclassified from mining extraction to manufacturing, this assumption is further challenged since it questions whether or not manufacturing had even declined. The oil sands is only one example of an industry that arguably could be classified as manufacturing: others include construction, genetically modified farming, and fast food restaurants.

More broadly, questions about classification underscore that our understanding of the economy is inherently uncertain and based on conven-

tions that change over time. These changes affect the definition of everything from GDP, to the unemployment rate, to what is included in various industry classifications. Industry classification issues promise to become even more complicated as technological change further blurs the lines between manufacturing and services.

Classification rules are inherently arbitrary

Many economic phenomena occur on a continuum, with lines arbitrarily drawn to classify them. A good example is the money supply, which has a wide variety of possible definitions ranging from the narrow (based on cash and chequing deposits) to progressively broader inclusions of savings deposits, money market funds, and other less liquid investment vehicles. The elasticity and arbitrariness in the definition of money has long been acknowledged by central banks, which produce a wide range of measures without formally endorsing one over the others.

Instead of following the elastic approach of central banks to defining money, statistical agencies adopt one definition of an industry, such as manufacturing, and discourage analysts from considering alternative points of view. The unemployment rate is one area where statistical agencies acknowledge that a range of different measures is possible. Canada publishes eight different measures while the US Bureau of Labor Statistics has six. However, both organizations sanction one measure as their “official rate” of unemployment.

All statistical taxonomies involve some degree of arbitrariness. It is well known, for example, that what is included in GDP has changed over time as the economy itself has evolved (such as the 2012 decision to include investments in research and development in capital formation). Basic concepts of employment and the unemployment rate also have evolved over time as the economy and social norms change; at one time, 14-year olds were included in the labour force survey. Today, Canada still includes 15-year olds in its labour force survey (although another MLI paper has argued that Statistics Canada should adopt the US practice of excluding them) (see Cross 2015a). One can argue and debate where

the line is drawn for all of these definitions, and the same is true of the classification of industries. More questioning and debate is needed because our knowledge of the economy, like the world around us, is constantly changing.

Rather than a rigid yet vaguely-defined black-and-white classification of an industry as resource extraction, manufacturing, or a service, this paper argues that all industries occupy a place on a broad continuum of production processes and outputs – and the delineation among them inevitably is open to debate. This paper also argues that statisticians may have drawn the line between resource extraction and manufacturing inappropriately (which is not to say incorrectly, since it is hard to definitively be right or wrong about classification issues) for Canada’s oil sands. One conclusion of the paper is that public policy discussions should not be bound by a rigid definition of manufacturing, any more than analysts use one definition of the money supply, unemployment, or natural resources (a recent MLI paper found a dozen definitions of natural resources have been used in Canada) (Cross 2015b, 9).

Analysts accept that the definition of the money supply or unemployment is variable, yet have trouble carrying this notion of variability into discussions of industry classification. An awareness of the malleable definitions of basic concepts and how they change our perception of the way the economy works will help analysts and policy-makers avoid the pitfall of believing that growth depends on encouraging one group of industries over another. As technological change continues to blur the distinction between resource extraction, manufacturing, construction and services, the debate this paper hopes to initiate about what is manufacturing marks only the beginning of a broader discussion about the many issues surrounding classification.

Classification can be vitally important to how businesses operate. The United States, for example, had banned exports of crude oil since 1975, but allowed exports of refined petroleum products. As the shale oil revolution boosted US output of crude oil and depressed its price, firms circumvented the ban by arguing that the addition of some condensates to remove volatile ele-

ments from oil qualified as refining. The process peels off fuels like butane and propane and is routinely done in oil fields, but firms appealed successfully to the US Department of Commerce that the resulting product was no longer crude oil, “even though it is a far cry from the traditional refining process” (Berthelsen and Cook 2014) (note that this reclassification did not involve the official statistical arm of the Department of Commerce). As *The Economist* concluded, “The definition of what constitutes crude oil owes more to art (and bureaucratic fiat) than science” (The Economist 2015).²

What is Manufacturing?

Manufacturing today bears little resemblance to its origins. Manufacturing literally comes from the Latin words for *manus* (meaning “hand”) and *facio* (meaning “to do”) (Marsh 2012, 5). The reference to “hand” reflects how manufacturing used to be a labour-intensive artisanal process. In the 19th century, plants were referred to as manufactories, which over time was shortened to just factories.

Manufacturing involves the transformation of materials or substances into another product, which can be a finished product ready to be consumed, or a product destined to be an input for the production of other goods and services.³ Most of the basic materials produced by manufacturers have existed for thousands of years, including glass, ceramics, concrete, timber, and iron and steel. Paper was invented in China about 2,000 years ago. Only rubber, aluminum, and plastics date from the Industrial Revolution and were created for specific purposes. However, new materials began proliferating early in the 20th century, such as graphene and carbon fibre.

In practice, the definition of manufacturing has fundamentally changed over time. Robert Fogel, a leading economic historian, has noted that Censuses in the United States in the 19th century made no distinction between agriculture and manufacturing (Fogel 1989, 103). The 1840

Census lumped agriculture, manufacturing, construction, and mining into one category. The 1850 and 1860 Censuses included in agriculture many farm-based manufacturing operations such as sugar production and rice cleaning. This reflected how 19th century farming inextricably involved manufacturing activities such as woodworking and metal shaping (to make and repair farm equipment) and the milling, processing, and slaughtering of livestock and crops.

Several manufacturing industries evolved to take on part of the work done on farms. As Michael Bliss recounts, “A few mechanically inclined farmers who wanted more ‘labour-saving devices’ enjoyed tinkering around the barnyard with ploughs, cutting tools, rakes, and old wheels.” Out of such tinkering grew one of Canada’s first multinational manufacturing companies: “In the mid-1840s [Vincent] Massey began spending most of his time in a little repair shop on his own farm, then bought into a small foundry in the village of Newcastle, and ran it as a family business from 1849” (Bliss 1987, 240).

Food processing, today the largest manufacturing industry in Canada, often began on farms, with “farmers making sausage, farmers selling butter and cheese at local markets or trading them with country storekeepers” (Bliss 1987, 242). In some instances, the farmer’s activities encompassed the primary sector of agricultural production, the secondary sector of manufacturing, and the tertiary sector of providing a retail or wholesale service.

Today, the three North American statistical agencies define manufacturing as comprising “establishments primarily engaged in the chemical, mechanical or physical transformation of materials or substances into new products. These products may be finished, in the sense that they are ready to be used or consumed, or semi-finished, in the sense of becoming a raw material for an establishment to use in further manufacturing. Related activities, such as the assembly of the component parts of manufactured goods; the blending of materials; and the finishing of manufactured products by dyeing, heat-treating, plating and similar operations are also treated as manufacturing activities” (Statistics Canada 2012).

The key phrase in this definition is the transformation of materials or substances into “new products.” One can easily understand that combining metals, plastics, and glass into a motor vehicle results in a product that is fundamentally new and different from its inputs. However, this same definition of manufacturing classifies pieces of lumber as new and different from a log, or that refined metals are new and different from metal ore. If one accepts (as statistical agencies do) that lumber is a “new” product compared with a log, or metal alloys are new compared with metal ores, then on what grounds is upgraded bitumen or heavy oil not different and new compared with raw oil sand ore, especially when bitumen can be used as a finished product for some purposes? And almost all construction activity meets the definition of transforming materials into new products.

Statistics Canada argues that “the initial processing of natural resource products is a clear extension of the extraction industry and therefore is included within the natural resource sector,” but quickly notes that “These products are often classified as manufactured goods... since the processes physically transform inputs” (Provenzano, Barber-Dueck, and Floyd 2016). This clearly points to early-stage processing as being part of natural resource activity broadly defined, and specifically as part of manufacturing within its industry classification.

Once the three statistical agencies have agreed on a classification, there is little or no room for individual agencies to implement it arbitrarily. This standardization has the advantage that what is included in various industries does not vary when comparing statistics across nations. (It is notable that this standardization of industry classifications does not extend to most statistical concepts; the definition of housing prices or unemployment varies widely between Canada and the US. Even something as relatively simple as retail sales varies, with the US including restaurants while Canada does not.)

On a practical level, classifying a company or establishment into a particular industry cannot be changed too often. For example, in the mid-2000s, Ford sharply reduced its assembly of vehicles in Canada from a high of 266,000 units in

1999 to about 140,000 units in 2005 and 2006. This raised the question of whether Statistics Canada should reclassify Ford’s operations from manufacturing to wholesaling, which became its principal business operation as it imported more vehicles from the US. However, in 2007 Ford raised vehicle assemblies in Canada to over 300,000 units when it started to produce the Edge line (Statistics Canada 2017d). Strictly speaking, Statistics Canada should have re-classified Ford from a manufacturer to a wholesaler for a couple of years and then back to a manufacturer. It did not because of the confusion this shifting would have created for analysis, with a sharp drop in manufacturing output followed by a marked rebound.

So it has to be acknowledged that some stability in classification is required to make sense of long-term trends in industry output. However, a need for consistency and stability does not apply to the classification of the oil sands because the primordial upgrading and transformation of oil sand into bitumen at the start of its production process has not changed since commercial development began in earnest. The same applies to construction. Conversely, the change to agriculture from genetic modification and enhancement qualifies as transformative, implying that an activity once allocated to agriculture could be re-assigned to manufacturing, a serious complication for analysis.

What is Unique About Manufacturing?

It has always been difficult to differentiate between some manufacturing activities and other goods production. Construction, for example, has long been classified with manufacturing in the secondary sector. This is because there is a close similarity between manufacturing and construction activity. As one analyst noted, construction “is manufacturing outside of a factory” (Orthwein 2014, 103). Like manufacturing, it takes inputs and transforms them into an output. The builder of 1 World Trade Centre called it “the most complicated manufacturing event”

he had worked on (Sanburn 2014). The building of the Leadenhall high-rise in London was mostly done off-site (including the wiring and plumbing), allowing just 24 workers to assemble the modular building blocks over three years (see Chambers and Oliver 2014).

Classification is a good example of knowledge that has to be deduced from principles, not inducted from evidence. The difference is clear in the official definitions of construction and manufacturing. The North American Industry Classification System (NAICS) definition of construction is “establishments primarily engaged in constructing, repairing and renovating buildings and engineering works, and in subdividing and developing land” (Statistics Canada 2012). This definition is unsatisfactory because it avoids a definition of what activity constitutes construction; it presumes that we already know what firms are engaged in construction, repairing, and renovating without defining what those activities really are. This is unlike the NAICS definition of manufacturing, which does specify the activity that constitutes manufacturing (essentially, taking materials and transforming them) rather than focusing on a characteristic of that process (such as relying extensively on intermediate inputs, which presupposes that we can define manufacturing without using intermediate inputs as a guide).

“ Similarly, it is difficult to distinguish between some primary resource industries and manufacturing.”

Distinguishing between manufacturing and construction seems to come down to whether the work was done inside a factory or outside. However, this distinction is becoming blurred, as more construction is done on pre-fabricated units assembled inside a factory and as the 3D manufacturing revolution allows output to be printed anywhere. 3D manufacturing, also called “printing,” was explicitly developed to enable manufacturing to be unconstrained by a fixed geographic

location; it was first developed for use in nuclear submarines that needed replacement parts but could not surface or enter a port for months at a time (Heck and Rogers 2014, 86).

Construction is increasingly becoming manufacturing that takes place outside of factories, but location is not referred to anywhere in the “official” definition of construction and should not be a consideration. (Statistics Canada (2012) does refer to location when defining manufacturing, as “Manufacturing may take place in factories or in workers’ homes” in a nod to the cottage industry origins of manufacturing in the western world and how this continues in many poorer countries today.)

Similarly, it is difficult to distinguish between some primary resource industries and manufacturing. Conventionally, extractive resources are allocated to the primary sector if there is little or no processing, while processing operations such as the milling of grain, the slaughter of animals, transforming timber into wood or pulp and paper, and the smelting and refining of metals are treated as manufacturing. However, extensive processing occurs in some industries that are classified as mining. For example, uranium has always been milled on site into yellowcake and then enriched to the purity required by nuclear plants (Ritchie 1997, 30). Conversely, iron ore is treated as mining and steel as manufacturing, although modern steel “is metallurgically a form of iron rather than what has traditionally been meant by ‘steel’” (Drucker 2016, 31).

Some physical transformations of a product do not involve any change in the product’s substance, and therefore are not manufacturing. For example, liquefying natural gas (by cooling it) only temporarily alters the form of natural gas so it can be transported more efficiently. It is then returned to its previous gaseous state, with no change in its underlying composition. Therefore, terminals producing liquefied natural gas should be regarded as part of mining and not manufacturing.

Farming increasingly resembles a manufacturing operation. This is not because its methods have become mechanized and computerized, which boosts efficiency and productivity but does not

change its output. The more fundamental transformation is that more farming output is based on genetic manipulation, known as “genome editing.” This manipulates the most elemental input – plant genomes – down to the level of a single genetic “letter” to produce the output of a consumable plant (The Economist 2016). This appears to satisfy the statistical definition of what constitutes manufacturing.

Some analysts have even called into question how different manufacturing is from services. Greg Mankiw, then head of the US Council of Economic Advisors to President George W. Bush, asked, “When a fast-food restaurant sells a hamburger, for example, is it providing a “service” or is it combining inputs to “manufacture” a product?” (Council of Economic Advisers 2004, 73). Fast food restaurants rearrange the basic inputs of agricultural produce to sell a standardized product. Again, it is difficult to distinguish this process from the technical description of manufacturing used by statistical agencies.

In another example, Mankiw notes that combining water and concentrate in a bottling plant to produce a soft drink is classified as manufacturing, but if it is done at a snack bar, it is considered a service (Council of Economic Advisers 2004, 74). This highlights one of the shortfalls of the official statistical definition of manufacturing, in that all industries take inputs and transform them into new products. Otherwise, the industry would have no value-added and would quickly go out of business.

The relationship between manufacturing and services has become more complex over time. It has long been understood that many manufacturers produced services in-house, from running a cafeteria to doing their own tax and legal work. Some of the decline in the measured size of manufacturing output and employment in recent decades reflects the outsourcing of these services to firms that specialize in their production.⁴ More recently, it is manufacturers who are increasingly providing service outputs to their customers. The value-added from assembling parts is often an almost trivial part of the production process (1.6 percent in the case of Apple iPads) (The Economist 2017).

Many manufacturers have always prided themselves on the after-sale service they provide. As manufacturing has become more capital-intensive and technologically-advanced, it is easier to embed a flow of ongoing services directly into a manufactured good. These are many examples of a steady stream of services provided by a manufacturer. A smartphone’s capabilities are continually upgraded by software updates and purchases of apps, a trend now being extended even to mundane items like cookware. A self-driving Tesla vehicle is continuously updated with information transmitted from the road experience of all other similar Teslas.

There are other ways services are combined with manufacturing; for example, some auto companies include the cost of several years of scheduled maintenance in the list purchase price. Increasingly, firms sell data on their customer’s purchases or characteristics (in the US, the Kroger supermarket chain made \$100 million from such sales) (Monga 2014). Nortel Networks sold its technology patents for more than it received for its operating businesses after it filed for bankruptcy (Monga 2014).

The eagerness of many firms and industries to claim they are manufacturers reflects that it has a certain cachet in our society that goes back to the Industrial Revolution. However, not all claims that a company or an industry is a manufacturer are accurate. Too often people working in an industry proclaim they are manufacturers because they are rigorous, disciplined, produce to a fixed schedule, or use lean manufacturing techniques such as short lead times and reusable equipment to adjust output quickly.⁵ Chesapeake, one of the industry leaders in the fracking of oil and gas, was wrong to describe itself as a manufacturing operation that converted four inputs (leaseholds, capital, science, and human resources) into the output of oil and gas (Gold 2014, 190).⁶ Similarly, *The Economist* argued that “Farms are becoming more like factories: tightly controlled operations for turning out reliable products, immune as far as possible from the vagaries of nature” (The Economist 2016). Agriculture may be in the process of becoming part of manufacturing, but not for this reason. With very few exceptions, every company, organization, and industry uses inputs to produce

outputs, and all strive to be more efficient. That is not what defines manufacturing.

A more recent trend has been the rise of ‘factory-less’ goods producers. This involves a firm that abandons making goods in its own factories altogether, and subcontracts this job to others. In the words of one author, “The company concerned still properly describes itself as a manufacturer, since it holds legal title to product and designs and sells them. However, in the purest sense it no longer makes things” (The Economist 2016, 82). At the moment, statistical agencies classify factory-less goods producers as manufacturers if they “completely outsource the transformation process but own the input materials” (Statistics Canada 2012). Companies that outsource the transformative process but do not own the materials are classified as wholesaling.

Cisco, Nike, and Dyson are all examples of companies that outsource most of their factory production to a network of suppliers. Even auto producers are moving in this direction, with parts suppliers capable of making and assembling all of the components that go into the production of a vehicle. “Manufacturing has now become just another ‘cloud service’ that you can access from Web browsers, using a tiny amount of industrial infrastructure as and when you need it... much as we can access the huge server farms of Google or Apple to store our photos or process our e-mail.”⁷

One of the main implications for the future is that there is no reason for policy-makers to favour one sector over another, especially as it becomes increasingly difficult to distinguish between mining, manufacturing, construction, and some services. Currently, there is a wide range of differential tax rates, depreciation schedules, and subsidies, depending on whether a firm’s main activity is mining or manufacturing or services. Jack Mintz, Canada’s leading expert on taxation, estimates that the effective tax rate in Canada for 2014 varied from 3.2 percent in forestry and 8.2 percent in manufacturing to a high of 24.8 percent in construction and over 23 percent in services such as trade and communications (Mintz 2015, 17).⁸ It would be simpler and more efficient to level the playing field for all industries, instead of government arbitrarily favouring one sector (such as manufacturing) over others.

The very nature of manufacturing is changing. Starting in the Industrial Revolution, manufacturing became synonymous with mass production and standardization, particularly after Henry Ford perfected the assembly line. Now, with the advent of 3D manufacturing, mass customization (also called mass personalization) is replacing mass standardization. Examples include Toyota’s Production System that makes vehicles according to customer specifications, or Essilor that makes about one-third of its eyeglass lenses according to orders from individual opticians (Anderson 2012, 56-57).

3D manufacturing promises to accelerate the shift of manufacturing away from making things. With 3D manufacturing “the purchase of a design can in turn be manufactured, in a sense, by the buyer, either on a 3-D printer at home or one owned by a local print shop” (Sundararajan 2016, 58). Data becomes the key product that changes hands.

Case Study: Are the Oil Sands Mining or Manufacturing?

Many natural resources have to be refined from their natural state to be useful to humans. Grain has to be milled and baked to be digestible; sugar cane needs to be refined into sugar; most metals must be smelted and refined; crude oil has to be refined to meet the diverse demands for its products.

Statistics Canada treats all mining activity up to and including upgrading as mining, classifying only separate free-standing refining facilities as manufacturing. However, one is immediately confronted with the problem of distinguishing between upgrading and refining, which arguably is a matter of semantics. Upgrading is by all accounts a refining activity, since it focuses on the heavy components of a barrel of oil. Like a refinery, an upgrader produces intermediate

light crude oil as well as products such as diesel, which also are produced by refineries. In the instance of Shell's Scottford operation, the lines blur further as the upgrading is not conducted separately in the field but is integrated into the refinery. Both upgraders and refineries produce both intermediate and finished products, which is not the same as an end product. A finished product simply means the oil industry is finished transforming the oil so it can be used by the consumer (such as gasoline or home heating oil) while an intermediate product is used as an input into another production process (such as in petrochemical processing).

“*What makes the oil sands unique is that bitumen is pre-processed, or partially upgraded, by the very process of extraction.*”

What makes the oil sands unique is that bitumen is pre-processed, or partially upgraded, by the very process of extraction. To start, the sand, clay, water, and other debris in “oil sand” ore has to be removed at the extraction site. (This is why it is erroneous to call the oil sands “tar sands”; oil is the commodity trapped in the mixture of sand and other substances, while tar is a man-made substance that does not exist in oil sand.) In the surface mining procedure, the oil sand ore is mixed with hot water and caustic soda to make what is called slurry. The slurry is then piped to an extraction plant, where it is agitated so the oil can be skimmed from the top.

At this point the product is raw bitumen. It is further treated to remove residual water and solids (sometimes by adding a solvent which must later be removed), producing the extra-heavy crude oil known as bitumen. This still cannot flow in pipelines, so either diluent is added so it can be shipped, or it is upgraded at or near the extraction site. Diluent itself is an important and costly addition, adding nearly one-third to the volume of the “dilbit” (diluent mixed with bitumen) shipped by pipeline. A recent paper proposed partially upgrading bitumen to eliminate the need to add

diluent, reducing the cost of shipping and freeing up valuable pipeline capacity (Fellows, Mansell, Schlenker, and Winter 2017, 13).

Besides surface mining, there are many different ways of extracting oil sand. Some extraction techniques transform the oil sand at the very beginning of the extraction process. In the “toe to heel air injection” method, the oil sand is burned in the underground reservoir in which it is found in its natural state, which upgrades some of the oil sand directly into lighter oil, bypassing the bitumen stage altogether (while toe to heel air injection is not widely used now, it is an example of what is technologically possible). In situ (Latin for “in place”) techniques, notably Steam Assisted Gravity Drainage (SAGD), also involves heating at a high enough temperature to transform the product.

Future developments are focused on the increased use of solvents, which reduce or even eliminate the need for water and steam. Solvents have the potential to separate some of the heaviest components of bitumen, leaving them in situ. Arguably, this could be interpreted as a form of upgrading which would have the side benefit of reducing the need for diluent while also producing a more valuable product. As described by energy expert Daniel Yergin, “The in situ process uses natural gas to create superhot steam that is injected to heat the bitumen underground. The resulting liquid—a combination of bitumen and hot water—is fluid enough to flow into a well and to the surface” (Yergin 2011, 256). In situ already accounts for a majority of oil sands production, which is why Yergin says that eventually “most of these unconventional oils will have a new name. They will all be called conventional” (Yergin 2011, 262).

Currently there are 27 active oil sands projects in Alberta. Six use surface mining production methods (with four of these having an upgrader) while 21 are in situ operations. About 40 percent of Alberta's bitumen is upgraded into synthetic crude oil, similar to light sweet crude oil. In situ operations typically have not had the scale to justify an upgrader (that was about to change as Nexen's SAGD operation had an upgrader, but after an accident it is not clear if it will be rebuilt) (Fellows, Mansell, Schlenker, and Winter 2017, 3).

One of the reasons it is hard to classify oil sands operations is that their technology and complexity vary widely. For example, the partial upgrading proposed by a report from the University of Calgary noted that there are 10 different possible techniques, with a range of complexity from 2 (the simplest) to 12 on the Nelson Index, which the industry uses to evaluate the complexity of a refinery (Fellows, Mansell, Schlenker, and Winter 2017, 5). It is telling that the Nelson Index, developed to evaluate refineries (an activity clearly classified as manufacturing by statisticians), results in two of the 10 possible oil sand upgraders being graded at 10 or above, and five matching or exceeding the average score of 6.5 for refineries in Europe (the most complex refineries score about 14 or 15).

““ *There is little in the NAICS definition of manufacturing that rules out oil sands production from being regarded as manufacturing.*”

There is little in the NAICS definition of manufacturing that rules out oil sands production from being regarded as manufacturing. In the words of Andrew Leach, a professor of energy policy at the Alberta School of Business, the oil sands are “a manufacturing business as much as anything else” (Leach 2014).⁹ Clearly, oil sands output does not follow the so-called “rip and ship” model of extracting (i.e., ripping resources out of the ground and shipping them without processing). Oil sands production involves processing raw oil sand ore into bitumen, and some bitumen is upgraded to produce both intermediary and final products, with most sent to refineries to be converted into a variety of petroleum products. It is arbitrary and debatable to maintain that upgrading oil sand to bitumen or heavy oil is not manufacturing, but refining is.

History is one reason oil sands production is classified as mining and not manufacturing. One of the earliest analyses in 1942 of the problems en-

countered by Abasand’s attempts to harness the oil sands described how “The operation consists of mining, separating, and refining” where the “mining consists of removal of overburden, drilling and blasting the beds of bituminous sand, digging with a power shovel and transporting the material by trucks to the Separation Plant.”¹⁰ This process was a mining operation, although it is notable that the mining, upgrading, and refining of the oil sand was all done at the same site. When oil sands production first began in earnest in the 1970s, the bucket wheel technology it borrowed from mining technology made it look like a mining operation, and indeed much (but not all) early work was conducted by mining firms and not oil companies.

The impression that the oil sands were a mining operation was reinforced by the surface mining technique adopted in the late 1990s, which remains prominent in media coverage of the oil sands. Today, over half of oil sands production is obtained by in situ methods of heating the raw oil sand underground and then collecting it, usually by Steam Assisted Gravity Drainage. However, this is almost never presented in media coverage, which prefers to dwell on the more sensational pictures of the open pit mines since in situ operations occupy a much smaller footprint and largely leave the surface intact. In all instances, oil sand operations require some transformation at the extraction site because of the near impossibility of transporting raw oil sand ore.

Besides the oil sands, the other major new development in oil production involves fracking. Fracking represents a change in the production process, involving the input of water and chemicals to extract oil embedded in shale rock formations. However, as radically new as its technology may be, its output is exactly the same as conventional oil and gas (in fact, fracking was applied to old fields to extract an estimated 700 million more barrels of oil between 1996 and 2001) (Lynch 2016, 107). Therefore, fracking for oil and gas is properly classified as conventional oil and gas production within the mining industry. While fracking may combine different inputs than conventional oil, this simply represents a new process to produce the same output of crude oil. By comparison, the oil sands produce bitumen and various types of heavy oil, which is distinct from the raw ore.

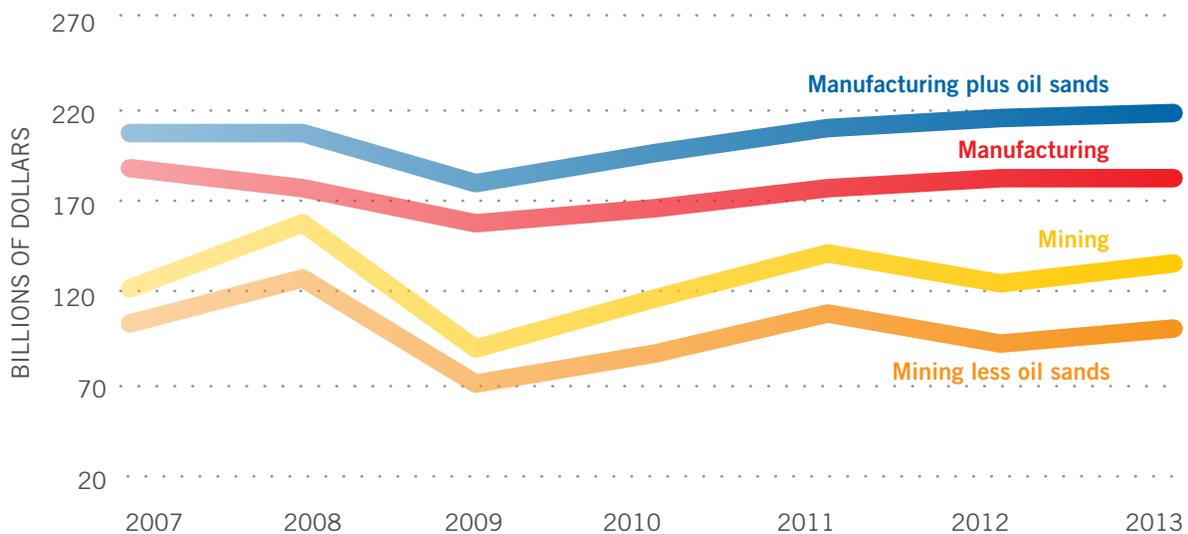
What Would be the Impact of Classifying the Oil sands as Manufacturing?

In terms of GDP, the value of output from the oil sands has grown from just under \$20 billion in 2006 to \$36.4 billion in 2013 (the latest year available for current-dollar industry

GDP). This growth has sustained Canada's overall GDP from mining at \$135.3 billion in 2011, up from about \$120 billion in 2006. At \$135.3 billion, total mining output is about three-quarters of the level of all manufacturing output of in 2013 (\$182 billion). Manufacturing output was below the high of \$187 billion it reached before the recession.

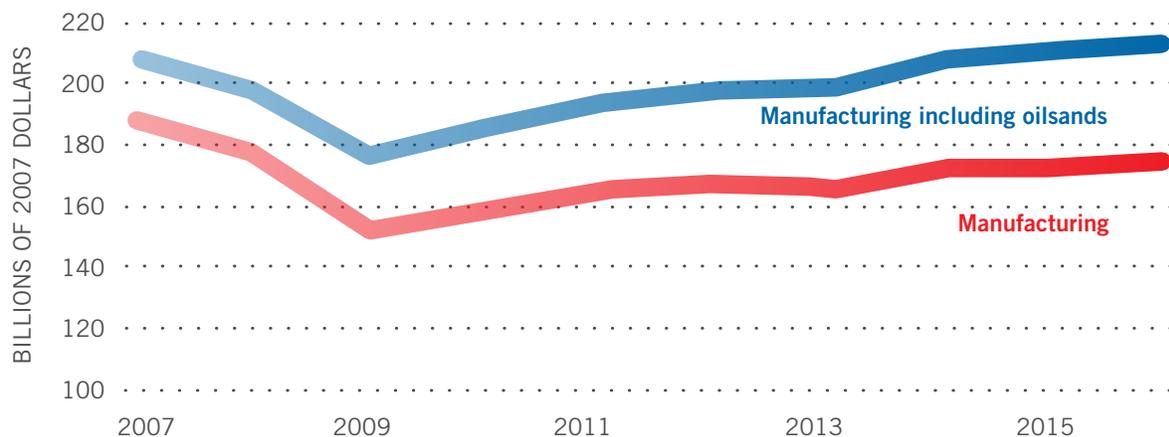
The overall picture is of a manufacturing sector in decline while growth in the oil sands sustains mining. This narrative is superficially presented as evidence of the so-called "Dutch Disease"

CHART 1: Gross Domestic Product



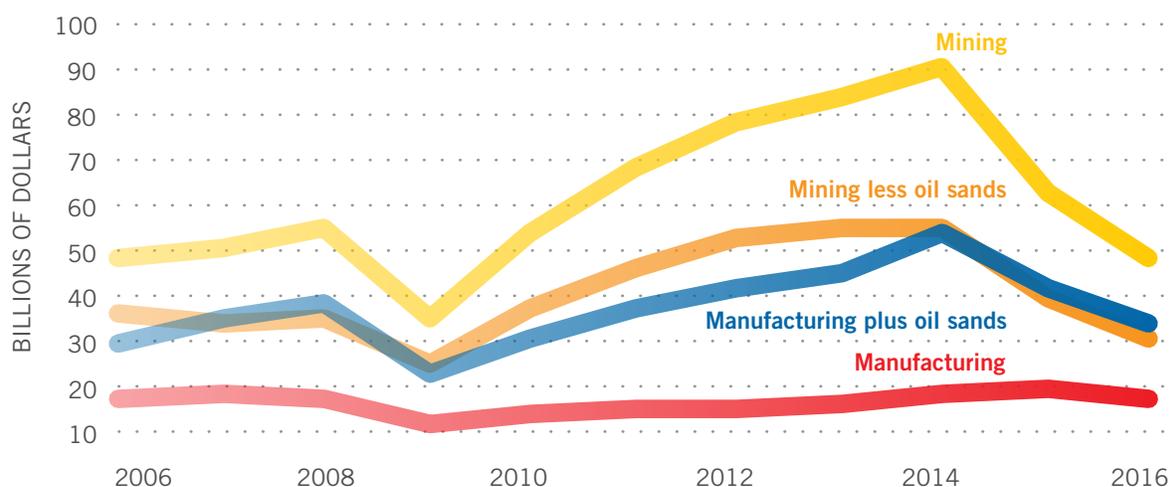
Source: Statistics Canada 2017a

CHART 2: Manufacturing GDP



Source: Statistics Canada 2017b

CHART 3: Capital Expenditures



Source: Statistics Canada 2017c

where a booming resource industry raises the exchange rate enough to reduce the competitiveness of manufacturing in the short term. However, this process only explains why manufacturing would be set back in the short run; over the long term, firms adjust their production process (including the use of more imported inputs) and cope with a higher exchange rate by reorienting their focus from export to domestic markets.

Reclassifying the oil sands from mining to manufacturing has the effect of magnifying the declining trend in mining while making manufacturing more than twice as important as mining (see chart 1). With the reclassification in place, mining excluding the oil sands shrinks from over \$100 billion before the recession to just \$98.9 billion in 2013. Meanwhile, manufacturing GDP grows from \$207 billion before the recession to a new high of \$219 billion in 2013.

The implications for the narrative about Canada's economy are profound. Instead of an expanding mining industry whose growth supposedly was strangling our factory base (based on the erroneous assumption that manufacturers are incapable of adapting to a higher exchange rate), Canada instead has an economy where the mining sector's struggles are dwarfed by a manufacturing industry that is twice as large as

mining and is thriving, once it is past the effect of the global recession. Well over half of manufacturing would originate in a wide range of resource-based industries (including the oil sands, food, wood, pulp and paper, primary metals, petroleum refining, chemicals and non-metallic minerals) as well as several capital goods industries (machinery, metal fabricating, electronic products, and aircraft), much of whose output is destined for the resource sector. Rather than mining being a damper on manufacturing's growth, the two sectors become mutually supportive and self-reinforcing.

The impact of expanding oil sands production is even larger looking at the volume of GDP (see chart 2). This is because oil sands output continued to grow in volume after 2014, even as prices fell. Again, the narrative of a shrinking manufacturing sector (down 9.3 percent in volume between 2007 and 2016) becomes one of growth, with manufacturing production including the oil sands up 3.3 percent over the past decade.

These trends in output mirror the behaviour of capital investment (see chart 3). Currently, with the oil sands allocated to mining, mining attracted investment at a rapid rate of nearly \$90 billion until 2014. Meanwhile, investment in manufacturing was less than \$20 billion and on a declining trend (with the exception of exten-

sive investments in the retooling of a couple of auto plants in 2014). When investment in the oil sands is shifted from mining to manufacturing, the narrative changes. Despite a modest boom from 2012 to 2014, capital spending in mining is trending downward; the spending is instead moving into manufacturing, despite the severe impact of the 2008-2009 recession.

“ *Resource-based manufacturing has always been an important part of Canada’s manufacturing.*”

One should not dismiss manufacturing growth just because it is based on natural resources, with or without the oil sands. Resource-based manufacturing has always been an important part of Canada’s manufacturing. Indeed, in the aftermath of the resurgence of the exchange rate after 2002 and the global recession of 2008-2009, resource-based manufacturing along with capital goods industries (such as machinery and equipment) have become the twin pillars of Canada’s manufacturing industry as traditional manufacturers such as textile, clothing, furniture, and autos struggled for a variety of reasons with intensified global competition.

Conclusion

As new products and technologies evolve, the textbook definition of manufacturing that statistical agencies use does not provide enough guidance and precision about what constitutes manufacturing. One example, which this paper has studied extensively, is the oil sands industry. It is difficult to rationalize how oil sands can be classified as mining while maintaining that the wood and smelting and refining industries are part of manufacturing.

These statistical issues are becoming more complicated as technology blurs the lines between

resource extraction, manufacturing, construction, and services. Genetic modification means agricultural inputs at their most basic level are being manipulated to change their output, which meets the textbook definition of manufacturing. Construction always has had a large element of manufacturing in its production process, except it takes place outside of a factory. Meanwhile, technological innovations such as 3D manufacturing allow more manufacturing production outside of conventional factories. At the extreme, some producers are classified to the manufacturing sector even if they operate no factories but only own the inputs that are used in factories operated by other firms. Technology enables an increasing number of providers of manufactured goods to also supply a stream of services, blurring the distinction between manufacturing and services.

Another implication of the difficult classification of a firm to one industry or another is that it is futile and even counter-productive for governments to bend taxes and subsidies to favour development in one industry over another. Instead, governments should level the playing field and allow the marketplace’s price system to determine where investment funds go to fund development.

These classification issues are not just of interest to accountants and statisticians. They fundamentally affect how analysts frame our view of how the economy functions and how it is evolving. To use the main example from this paper, the perception of Canada’s economy changes markedly depending on whether the oil sands are classified as mining or manufacturing. If kept in mining, it appears that over the past decade investment and output are shifting from manufacturing to mining, which encourages erroneous “Dutch Disease” thinking that growth in resources is harmful to manufacturing. However, if the oil sands are treated as manufacturing, the narrative becomes one where manufacturing in Canada is expanding and thriving as it shifts from its traditional bases in autos and clothing-related industries to resource-based manufacturing and capital goods that supply the resource industries.

About the Author



Philip Cross is a Munk Senior Fellow at the Macdonald-Laurier Institute. Prior to joining MLI, Mr. Cross spent 36 years at Statistics Canada specializing in macroeconomics. He was appointed Chief Economic Analyst in 2008 and was responsible for ensuring quality and coherency of all major economic statistics. During his career, he also wrote the “Current Economic Conditions” section of the *Canadian Economic Observer*, which provides Statistics Canada’s view of the economy. He is a frequent commentator on the economy and interpreter of Statistics Canada reports for the media and general public. He is also a member of the CD Howe Business Cycle Dating Committee.

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Endnotes

- 1 Although the form of help from tariffs has changed markedly, from Sir John A. Macdonald's National Policy of levying tariffs on imports to protect Canadian-produced manufactured goods to the 2015 policy of removing the tariff on goods imported by manufacturers.
- 2 The US Congress ultimately repealed the ban on crude oil exports in 2016.
- 3 A widely-cited article in *Challenge* incorrectly said, "Manufacturing transforms raw materials into finished goods." Many manufacturers produce materials used as inputs into the creation of other products such as steel or chemicals. (See Popkin and Kobe 2003, 65).
- 4 Manufacturing has one of the highest multipliers of any industry as a result of its extensive outsourcing (see Cross and Ghanem 2006).
- 5 This claim was made by an economist at BP. (See Mortished 2016.)
- 6 Fracking is discussed in more detail in the next section on mining.
- 7 Chris Anderson. *Makers: The New Industrial Revolution*. McClelland and Stewart, 2012, 60.
- 8 These estimates do not account for more favourable tax regimes for small businesses.
- 9 Leach also includes liquefying natural gas along with oil sands as "manufactured energy," a position this paper has argued against.
- 10 Quoted in Ferguson 1985, 107. Ferguson also notes the irony that the Abasand project combined American manpower with Canadian capital, the reverse of the usual collaboration in the mid-20th century.



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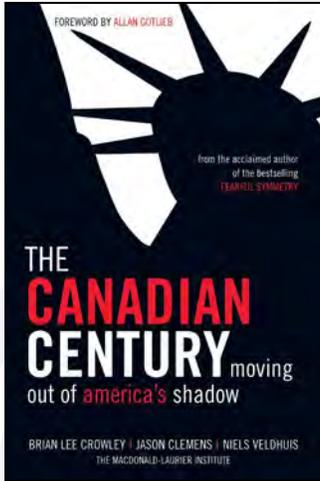
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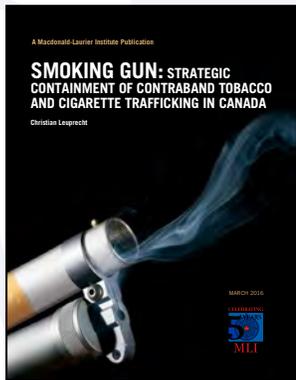
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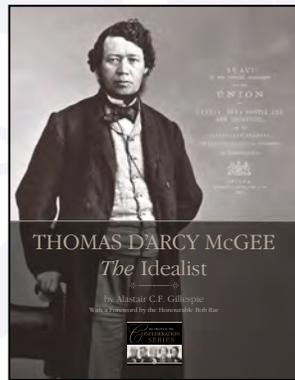
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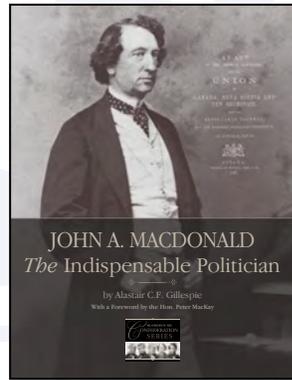
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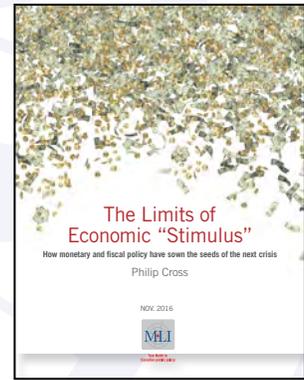
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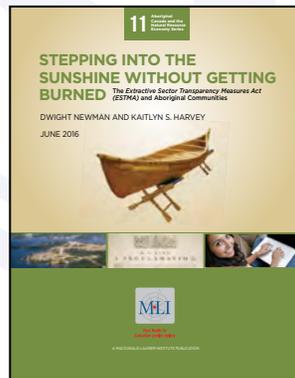
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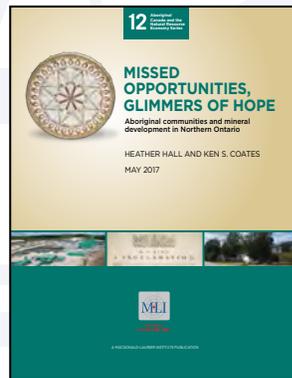
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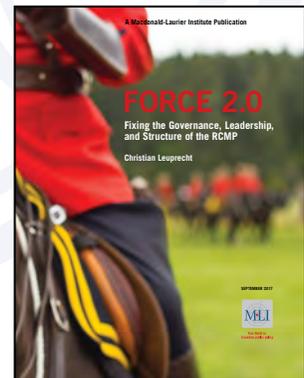
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True North in
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