Measuring Canadian export diversification

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Measuring Canadian export diversification

Introduction

Canada exports over $500 billion worth of merchandise trade annually. This reliance on foreign markets contributes significantly to Canadian economic activity. However, there are a number of ways of analyzing Canada's international trade, beyond simply measuring dollar values. One way, that often receives little attention, is to look at the degree of export diversification. Simply put, does an economy have one large customer or multiple customers, or does a country export one product or multiple products? Looking at international trade data through this lens provides additional information on the exposure of our domestic producers to risk beyond our borders, such as competitive pressures, commodity price and exchange rate volatility, as well as economic and political risk.

There are two types of diversification, as applied to international trade exports: diversification by product and geographic diversification. Diversification by product means spreading exports across a wide range of products. Geographic diversification means distributing trade across a number of partner countries.

Geographic diversification can also apply to provinces and territories. Diversification by province of production in this case refers to the degree to which Canadian exports are distributed evenly between the provinces and territories.

Statistics Canada has developed a set of concentration indices to measure the degree of diversification of Canada's international exports and to measure changes in the levels of diversification over time. These indices are high-level indicators that can be used to summarize the overall level of diversification across several dimensions of Canada's exports. This paper outlines the methodology used to create these measures and presents an analysis of the resulting data.

Methodology

To measure export diversification, the Herfindahl-Hirschman index (HHI) will be used as an inverse measure of diversification. This concentration ratio sums the squared shares of each commodity in total domestic exports and can be expressed as follows:

$$\text{HHI} = \sum_{i=1}^{N} \left(\frac{x_i}{X} \right)^2$$

where,

- x_i is the nominal domestic export value of commodity i,
- X is the country's total nominal domestic exports,
- N is the total number of export products.

This index was chosen, among many other concentration indices, to measure Canadian export diversification due to its simplicity of implementation, adaptability to different types of export diversification (product or geographic diversification), and because it possesses most of the characteristics of a good concentration index (see the Appendix). The Herfindahl-Hirschman index also attributes more weight to products (or markets) with larger shares by squaring shares before adding them up. This is an important feature when measuring concentration as the level of concentration will depend on both the number of commodities (or number of markets) as well as the distribution of their shares.

The chosen index results in specific bounds with a range varying between a lower bound of near zero, 1/N (indicating perfect diversification), and a maximum of 1 (representing perfect concentration of exports into a single product or to a single country of destination or from a single province of production). Lower values of HHI indicate a diversified set of products (or diversified markets of destination / provinces of production) whereas higher values

reveal a high degree of concentration (of exported products or markets of destination/origin) or equivalently, a less diversified export portfolio.

The United Nations Conference on Trade and Development (UNCTAD) measures export diversification using a normalized Herfindahl-Hirschman index, but provides no specific thresholds to differentiate between concentrated and diversified exports. To enhance the interpretation of the Herfindahl-Hirschman index, this paper draws from the Horizontal Merger Guidelines established by the Federal Trade Commission and the U.S. Department of Justice (August 2010) to differentiate between diversified, moderately concentrated and highly concentrated exports or markets. A summary of the three categories and thresholds used in this paper follows:

- Diversified (unconcentrated) exports or markets: HHI < 0.15

- Moderately concentrated Exports or markets : 0.15 ≤ HHI < 0.25

- Highly concentrated exports or markets : HHI ≥ 0.25

The following limitations of the Herfindahl-Hirschman index are worth noting:

- The Herfindahl-Hirschman index gives greater weight to larger export categories and is subject to an aggregation bias—the more disaggregated the input categories are, the less concentrated the resulting index will be (see the Appendix).

- In this paper, export concentration has been measured using nominal export values. Compared to real values, the use of nominal values serves to better represent the dispersion of actual receipts resulting from shipments abroad, and the availability of nominal value data across a number of key export dimensions allows for a more thorough study of diversification. It is worth noting, however, that the export concentration levels (by product or by market) presented in this study will be sensitive to volatility in both export quantity and commodity price. A graph representing Canada's product concentration using export data in real terms can be found in the Appendix.

In order to easily account for the evolution of the Herfindahl-Hirschman index over time, an index of the Herfindahl-Hirschman index, which, for simplicity, will be referred to as an index-of-the-index, will also be presented. The value of the index-of-the-index will be expressed as a percentage of a base value. The base value corresponds to the value of the Herfindahl-Hirschman index in 2012, the chosen base year for the purpose of the study. Thus, when comparing a concentration level in any given year with that in the base year, 2012, the difference between the given value of the index-of-the-index and 100 will represent the percentage change in concentration levels between the two years.

Product diversification

Canadian export portfolio diversification

The Herfindahl-Hirschman index for Canadian export products has consistently been lower than 0.15, at the Harmonized System (HS) 2-digit product aggregation level[1], throughout the period ranging from 1988 to 2016. Since 2015, decreased product concentration (increased diversification) was observed, falling from higher levels that occurred between 2011 and 2014, when the share of mineral fuels (mainly crude oil) in total exports was highest (28.0% on average) due to high oil prices.

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1. In measuring Canadian export product diversification using the Herfindahl-Hirschman index (HHI), export data are retrieved from the Canadian International Merchandise Trade (CIMT) program for the period 1988 to 2016, using the Canadian Export Classification (65-209-X), which is based on the Harmonized Description and Coding System (HS). The analysis is limited to Canadian domestic exports aggregated at the HS-02 level, excluding Chapters 98 and 99 (Special classification provisions), for a total of 96 product categories. The same database is used to calculate the degree of diversification of Canada's export destination markets and of the provinces of origin of Canadian exports.

Chart 1
Canadian export concentration, product
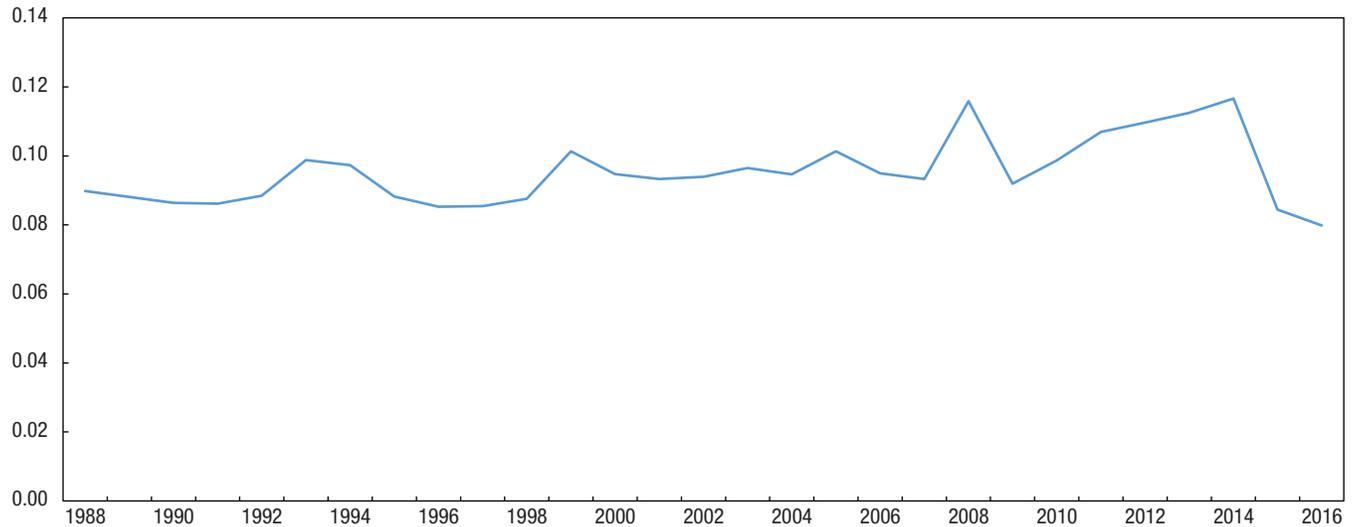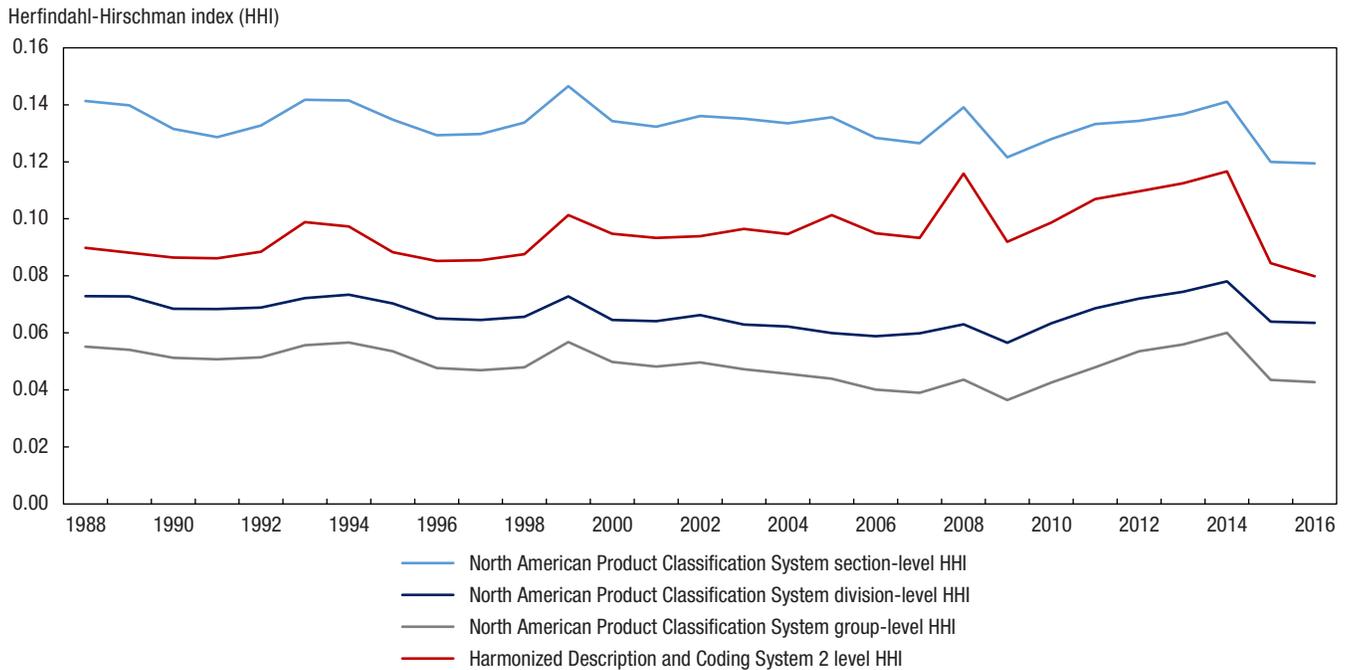
Herfindahl-Hirschman index (HHI)

Note: Important thresholds: Diversified exports where HHI is less than 0.15, moderately concentrated exports where HHI is 0.15 or greater and less than 0.25, highly concentrated exports where HHI is 0.25 or greater.
Source: Statistics Canada, CANSIM Table 228-0082.

In assessing export diversification, one should be mindful of both the product classification and aggregation level used, as these have a significant impact on the concentration ratio2. To emphasize this concept, the North American Product Classification System groupings (NAPCS) were also examined, excluding special transactions trade. At all three levels of aggregation studied (namely the Section, Division and Group levels), a relatively low concentration index of less than 0.15 was obtained, indicating export product diversification. However, when commodities are grouped into larger classes, the concentration level also increases to account for the size of the commodity grouping. In conclusion, Canadian goods sold in international markets are diversified by product, with their respective shares being distributed in a relatively uniform manner, as can be seen in Chart 2:

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2. One of the characteristics of a good concentration index is the reference to a classification of commodities (see the Appendix).

Chart 2
Canadian export concentration (product), various levels of aggregation

Herfindahl-Hirschman index (HHI)

North American Product Classification System section-level HHI
North American Product Classification System division-level HHI
North American Product Classification System group-level HHI
Harmonized Description and Coding System 2 level HHI

Note: Important thresholds: Diversified exports where HHI is less than 0.15, moderately concentrated exports where HHI is 0.15 or greater and less than 0.25, highly concentrated exports where HHI is 0.25 or greater.
Sources: Statistics Canada, CANSIM Table 228-0082 and Canadian International Merchandise Trade Program.

The United Nations Conference on Trade and Development (UNCTAD) publishes a concentration ratio based on the normalized Herfindahl-Hirschman index for a set of countries, including Canada. The data aggregation is based on the Standard International Classification (SITC, revision 3, at 3-digit group level), for a total of 261 products. Despite using a different classification system, the published concentration ratios are more or less consistent with ratios calculated at the HS-02 level, with Canadian exports to international markets being diversified for five years out of nine, while showing moderate concentration between 2011 and 2014. However, the published Herfindahl-Hirschman indices also portray Canada as the least diversified among all G7 member countries, as can be seen in Chart 3:

Chart 3
Export concentration of the G7 countries, product

Herfindahl-Hirschman index (HHI)
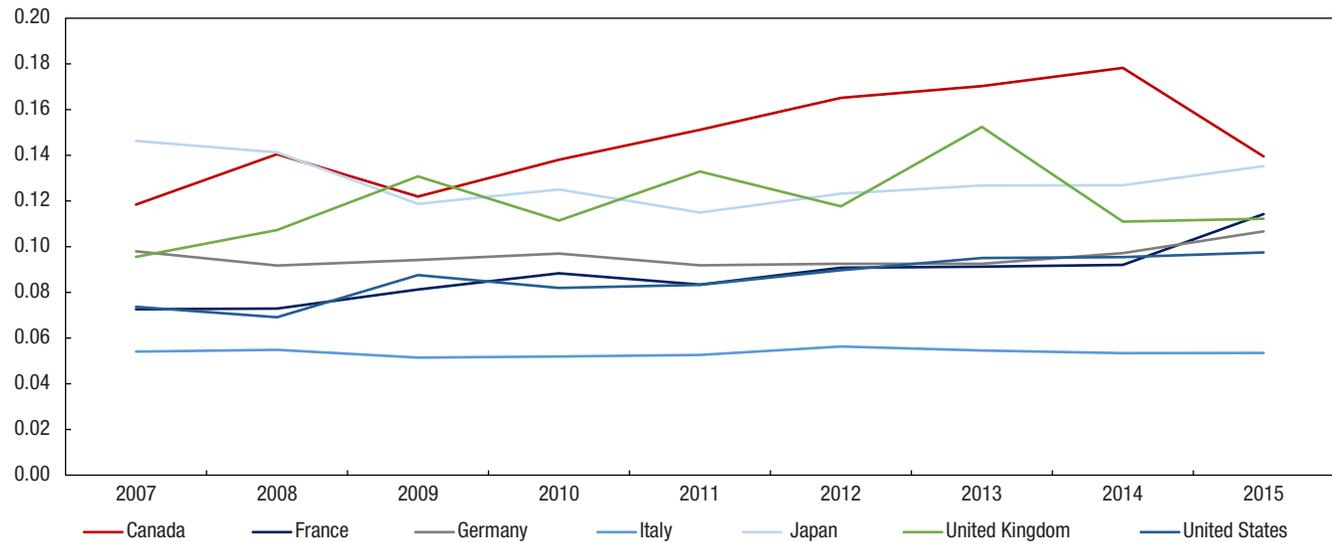
Sources: Merchandise: Product concentration and diversification indices of exports, annual, 1995-2015.

Mixed product diversification levels at the provincial level

Over the course of the past ten years, all Canadian provinces and territories have relied on export revenues as a contributor to their gross domestic product (GDP). With high commodity concentration levels, provincial export earnings may suffer from commodity price fluctuations driven by unexpected changes in global activity, and hence lead to significant terms of trade shocks.

Using the Herfindahl-Hirschman index as an inverse measure of product diversification, Canada's provinces and territories exhibited different levels of product diversification over the period 1988 to 2016.

Chart 4
Export concentration of the western provinces, product
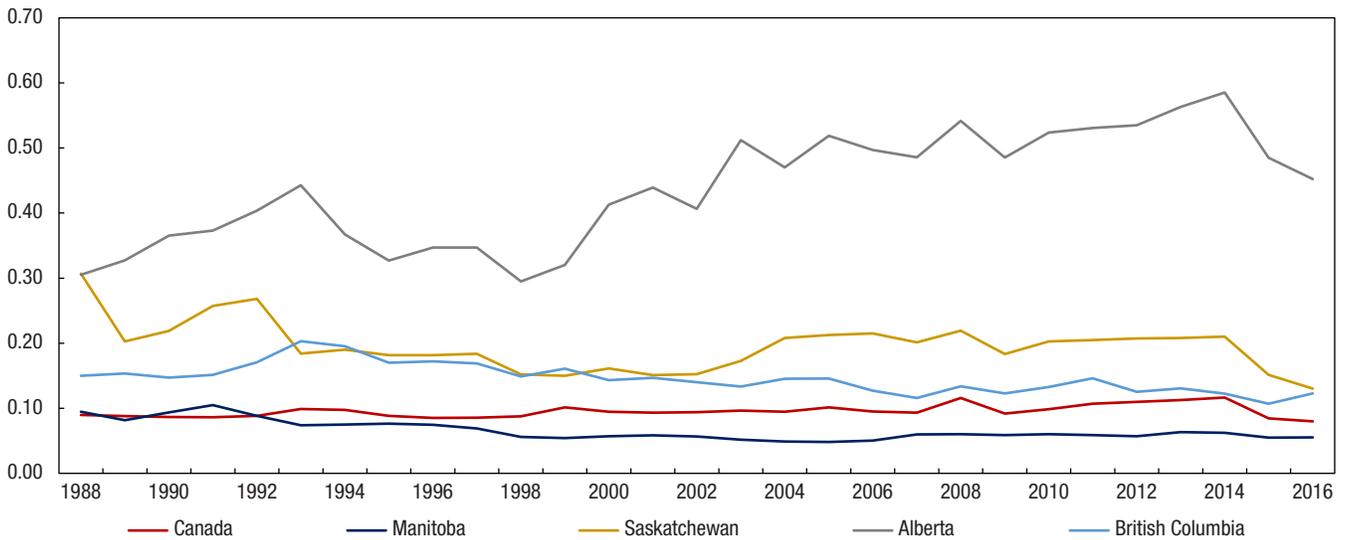
Herfindahl-Hirschman index (HHI)

Note: Important thresholds: Diversified exports where HHI is less than 0.15, moderately concentrated exports where HHI is 0.15 or greater and less than 0.25, highly concentrated exports where HHI is 0.25 or greater.
Source: Statistics Canada, CANSIM Table 228-0082.

With a concentration ratio of less than 0.15, Manitoba had a diversified basket of export goods throughout the entire time period, at the considered level of product aggregation.

Exports from Alberta were deemed highly concentrated as given by a Herfindahl-Hirschman index greater than 0.25 over the entire time period. Mineral fuels, mainly crude oil, accounted for the largest share, with 65.0% of the export mix originating from that province, on average.

The diversification level of exports produced in Saskatchewan and British Columbia changed over time. In the early years, Saskatchewan's exports were highly concentrated in cereals (wheat) with shipments of this product abroad representing 49.5% of the province's total exports in 1988. However, decreased exports of cereals (45.8% in 1992 to 13.4% in 2016) led to moderate concentration levels with mineral fuels (crude oil) and fertilizers (potash) making the top list of goods exported from that province in 2016.

The share of wood and articles of wood exported from British Columbia went from 28.2% in 1990 to 35.0% in 1999, thus leading to a moderate concentration of this province's exports over that time period. However, since 2000, international shipments from British Columbia were deemed diversified.

Chart 5
Export concentration of the central provinces, product
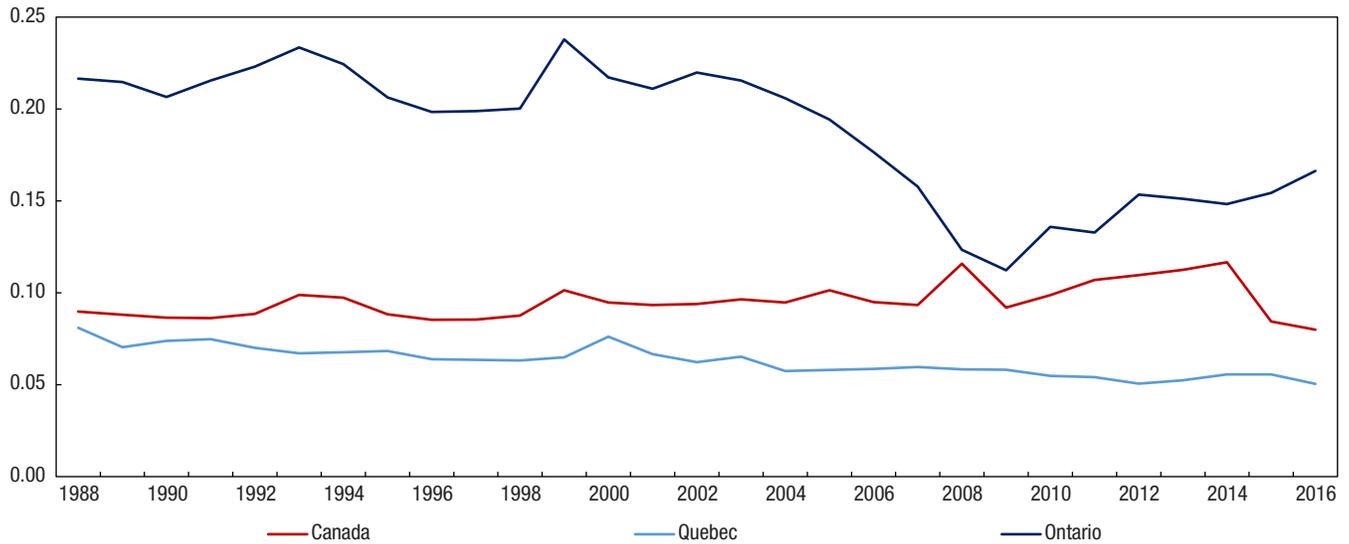
Herfindahl-Hirschman index (HHI)

Note: Important thresholds: Diversified exports where HHI is less than 0.15, moderately concentrated exports where HHI is 0.15 or greater and less than 0.25, highly concentrated exports where HHI is 0.25 or greater.
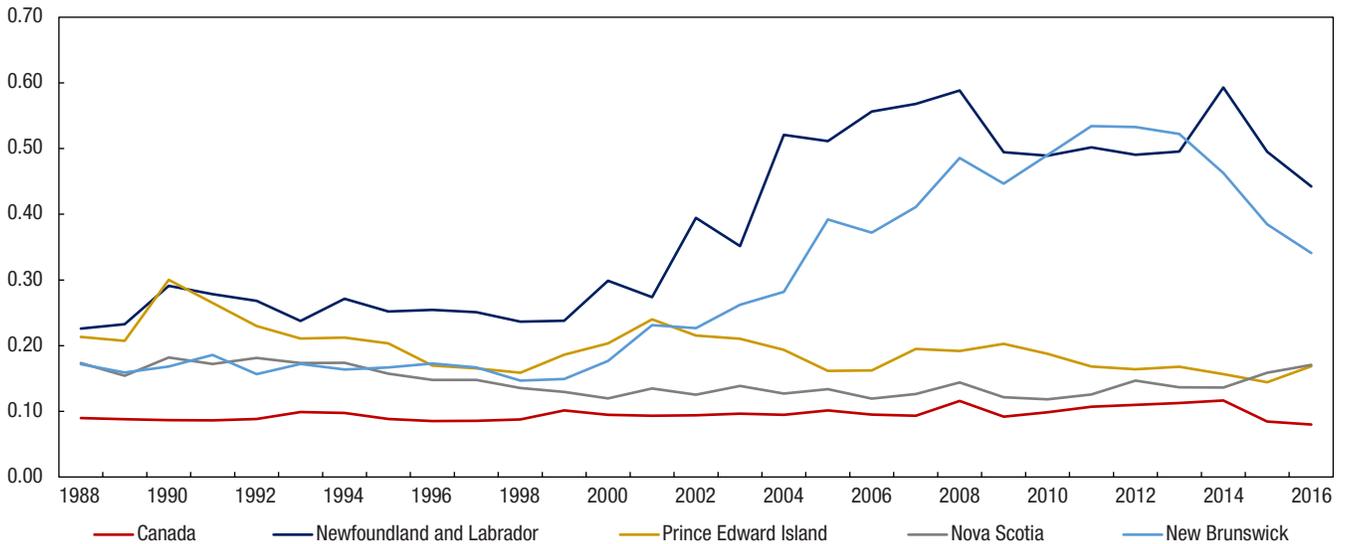**Source:** Statistics Canada, CANSIM Table 228-0082.

With a concentration ratio of less than 0.15, Quebec had a diversified basket of export goods throughout the entire time period, at the considered level of product aggregation.

Ontario's exports were deemed moderately concentrated for most of the period, mainly due to motor vehicles and parts (representing on average 43.0% of Ontario's exports prior to 2008). However, between 2008 and 2011, the share of motor vehicles in Ontario's total exports declined following the automotive industry downturn which led to diversified exports from that province.

Chart 6
Product concentration of the Atlantic provinces

Herfindahl-Hirschman index (HHI)

Note: Important thresholds: Diversified exports where HHI is less than 0.15, moderately concentrated exports where HHI is 0.15 or greater and less than 0.25, highly concentrated export where HHI is 0.25 or greater.
Source: Statistics Canada, CANSIM Table 228-0082.

Exports from Newfoundland and Labrador were deemed highly concentrated in mineral fuels, mainly crude oil, as given by a Herfindahl-Hirschman index greater than 0.25 throughout the considered time period. Since 1999, the product category mineral fuels held the largest share, representing on average 63.0% of the export mix originating from that province.

Exports from Nova Scotia were, for the most part, considered diversified, but for the period prior to 1996 and in recent years, they became moderately concentrated. The increased concentration level was mainly due to higher shares of prepared seafood products and of rubber and articles of rubber (tires) in total exports from that province.

Prince Edward Island was, in general, considered moderately concentrated with respect to merchandise exports. The main commodities sold to the rest of the world from this province were prepared fruits and vegetables, fish and crustaceans as well as parts of machinery (aircraft engines).

Up until 2002, New Brunswick's exports were deemed moderately concentrated but became highly concentrated in mineral products (mostly lubricants and other petroleum refinery products) thereafter, with this product representing on average about 63.3% of this province's total exports.

Chart 7
Export concentration of the territories, product

Herfindahl-Hirschman index (HHI)
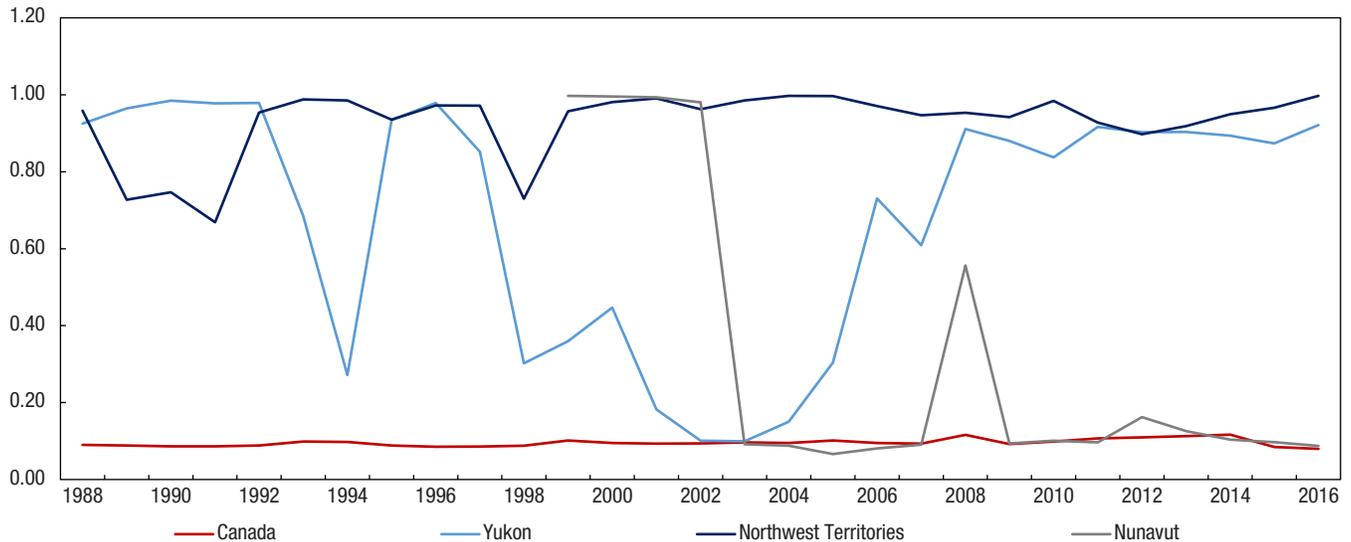
Note: Important thresholds: Diversified exports where HHI is less than 0.15, moderately concentrated exports where HHI is 0.15 or greater and less than 0.25, highly concentrated exports where HHI is 0.25 or greater.
Source: Statistics Canada, CANSIM Table 228-0082.

International shipments from the Yukon were in large part highly concentrated in ores (mainly copper) throughout the period of study, with this product category accounting for over 96.0% of total exports from that territory in 2016.

Exports from the Northwest Territories were deemed highly concentrated as given by a Herfindahl-Hirschman index greater than 0.25 over the entire time period. Prior to the division of this territory and the creation of Nunavut (1999), ores (lead and zinc) was the leading export, accounting for over 92.0% of total shipments from Northwest Territories. However, in the period thereafter, precious stones: mainly uncut diamonds held the largest share, representing over 98.0% of this territory's total shipments abroad.

Nunavut's exports switched from highly concentrated to diversified over time. Between 1999 and 2002, exports from Nunavut were highly concentrated into a single product category, ores (lead and zinc). However, by the end of 2002, all the zinc-lead mines in Nunavut were closed, and this led to a diversified portfolio of export products from that territory, due to a more uniform distribution of their respective shares.

Geographic diversification

Diversification by market of destination

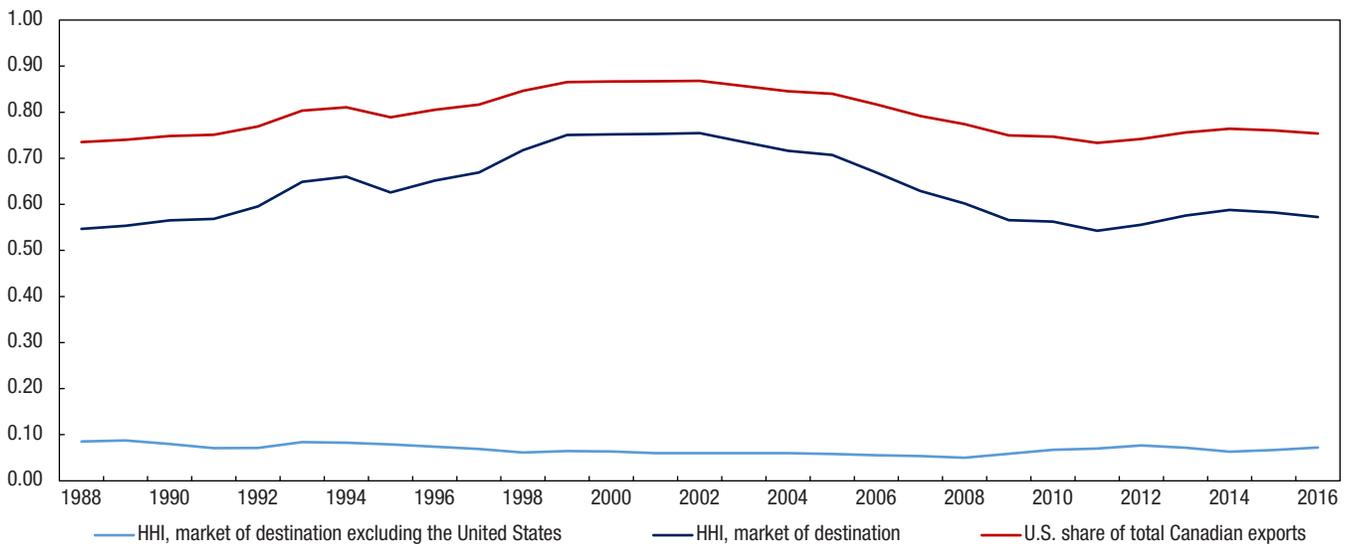### Canadian export destination markets are highly concentrated

The Herfindahl-Hirschman index can also be used to measure the concentration or diversification of Canadian export destinations. Between 1988 and 2016, Canada sent its exports to 240 different countries but had, on average, a concentration ratio of 0.63. Despite its numerous trading partners, Canada had a highly concentrated destination market, with the majority of its exports going to its neighbour and principal trading partner, the United States.

Among non-U.S. countries, Canadian exports were diversified by destination market, according to a Herfindahl-Hirschman index that has consistently been lower than 0.1 throughout the period 1988 to 2016. In 2016, China was the main destination market among non-U.S. countries (18.0% share of total Canadian exports to non-U.S. countries), followed by the United Kingdom (14.0%) and Japan (9.0%).

As can be expected, the Herfindahl-Hirschman index was highly correlated with the U.S. share of total Canadian exports. This can be seen in Chart 8:

Chart 8
Canadian export concentration, market of destination

Herfindahl-Hirschman index (HHI)

Legend:
— HHI, market of destination excluding the United States
— HHI, market of destination
— U.S. share of total Canadian exports

Note: Important thresholds: Diversified exports where HHI is less than 0.15, moderately concentrated exports where HHI is 0.15 or greater and less than 0.25, highly concentrated exports where HHI is 0.25 or greater.
Sources: Statistics Canada, CANSIM Table 228-0082 and Canadian International Merchandise Trade Program.

Between 1988 and 2002, the index-of-the-index was on the rise, which translates into Canada becoming more concentrated in terms of destination markets for its exports. This increased concentration coincided with a rise in the share of Canada's total exports to the United States, which went from 73.0% in 1988 to 87.0% by 2002. It is noteworthy that two of the Canada-U.S. trade agreements, the Canada-United States Free Trade Agreement and the North American Free Trade Agreement (NAFTA), were implemented in 1989 and 1994, respectively. The observed intensification of Canada's trade with the United States was likely a result of the elimination of tariffs and the reduction of non-tariff barriers on traded goods between the two countries.

Between 2002 and 2011, the Herfindahl-Hirschman index concentration fell from 0.75 to 0.54, reflecting less market concentration as a consequence of the importance given to new markets for Canadian exports. China and the United Kingdom saw their individual shares of total Canadian exports quadruple between 2002 and 2011, with combined exports to those countries accounting for 8.3% of total Canadian exports in 2011, up from 2.2% in 2002. The index-of-the-index fell 28.0% over that time period.

Beginning in 2012, the Canadian export destination pattern reverted back, with the U.S. share in Canadian exports strengthening again. In 2016, the concentration ratio was 3.0% higher than in 2012. Crude oil and motor vehicles were Canada's main exports, and nearly all exports of these commodities were flowing south of the border with Canada being a major supplier of heavy crude oil to the United States, and the highly integrated auto industry experiencing a resurgence following years of difficulty in the wake of the global economic crisis.

Diversification by province of production

Diversification of exports by province of production can also be examined to shed light on the origin of goods destined for export markets. The measure of diversification by province of production establishes the degree to which Canadian provinces participate equally in the production of goods destined for international markets.

Lack of diversification translates into Canada relying on a few provinces/territories for its export revenues. Furthermore, as provinces and territories have different resource endowments and different types of manufacturing, lack of diversification among provinces of origin implies that export receipts will be dependent on a few products specific to the exporting province or territory. Therefore, any sudden economic shock to either the province of production or the commodities exported could have a significant impact on national GDP.

Chart 9
Canadian export concentration, province of production

Herfindahl-Hirschman index (HHI)
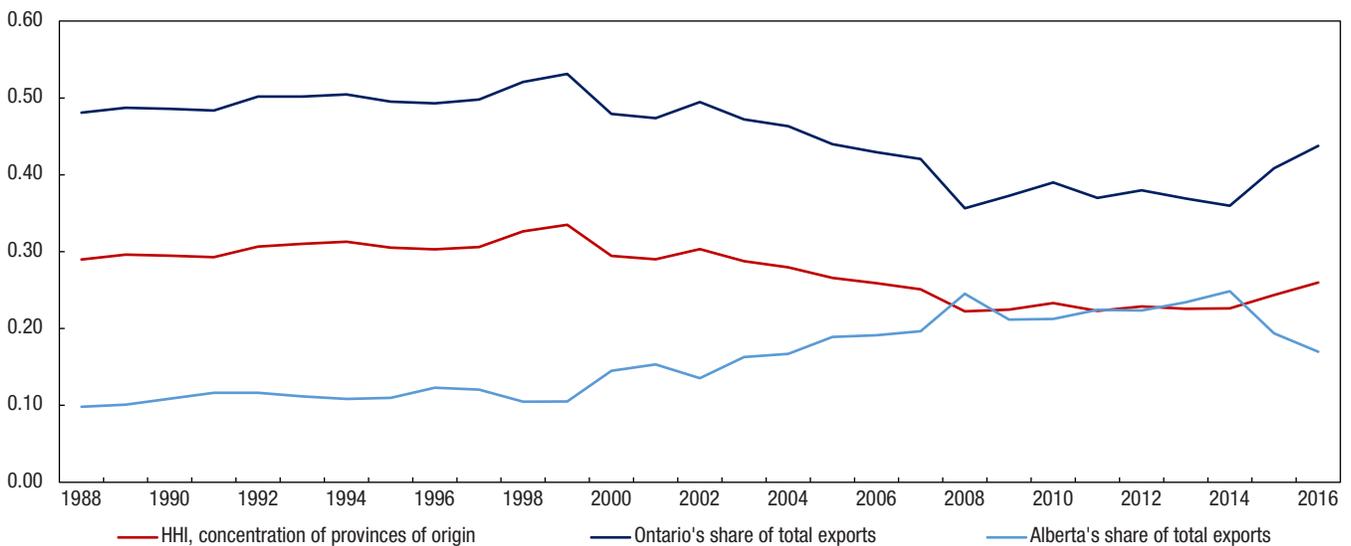
HHI, concentration of provinces of origin — Ontario's share of total exports — Alberta's share of total exports

Note: Important thresholds: Diversified exports where HHI is less than 0.15, moderately concentrated exports where HHI is 0.15 or greater and less than 0.25, highly concentrated exports where HHI is 0.25 or greater.
Sources: Statistics Canada, CANSIM Table 228-0082 and Canadian International Merchandise Trade Program.

All Canadian provinces and territories have been involved in trade activity with the rest of the world throughout the considered time period. However, in terms of provincial share of total exports, the concentration ratio as given by the Herfindahl-Hirschman index reveals that production of Canadian exports was highly concentrated in Ontario in 2016 and prior to 2008, but showed a moderate concentration between 2008 and 2015 (mainly in Ontario and Alberta).

Fluctuations in the concentration index closely followed those in Ontario's share in total exports, but were a mirror image of variations in the Alberta's share. Indeed, in 2016, despite all provinces and territories engaging in trading activities abroad, over 60.0% of products exported originated in Ontario or Alberta, with Ontario alone accounting for over 40.0%. Vehicles and parts have been Ontario's main export product while Alberta sold primarily mineral fuels to the rest of the world. The decrease in the concentration level of provinces of origin observed between 2008 and 2015 was mainly due to the 2008-09 global financial crisis and the resulting 2008-10 automotive crisis, both of which contributed to a significant decrease in exports of vehicles and parts from Ontario. Also contributing to this was an increase in Alberta's share of exports, driven by a rise in oil prices between 2010 and 2015.

Exports to Canada's main trading partners

### The U.S. market: product and market diversification

The United States is the destination of choice for most Canadian exports. An examination of diversification, at both the product and market levels, is prudent in order to assess the risk associated with commodity price fluctuations, exchange rate volatility as well as economic changes specific to a particular U.S. state.

The Chart 10 shows that Canadian products sold south of the border were diversified, with the exception of five years, namely 2008 and the period between 2011 and 2014 where the index indicated moderate product concentration. During those periods of increased product concentration, mineral fuels (mainly crude oil) accounted for over 33.0% of total Canadian exports to the United States, on higher crude oil prices.

The distribution of Canadian exports among U.S. states was also diversified, as indicated by a Herfindahl-Hirschman index that has consistently been lower than 0.13. Therefore, Canadian exports to the United States were not concentrated in any specific State but were rather distributed across U.S. states in a relatively uniform manner.

Chart 10
Exports to the United States, Canadian export concentration, product and market of destination
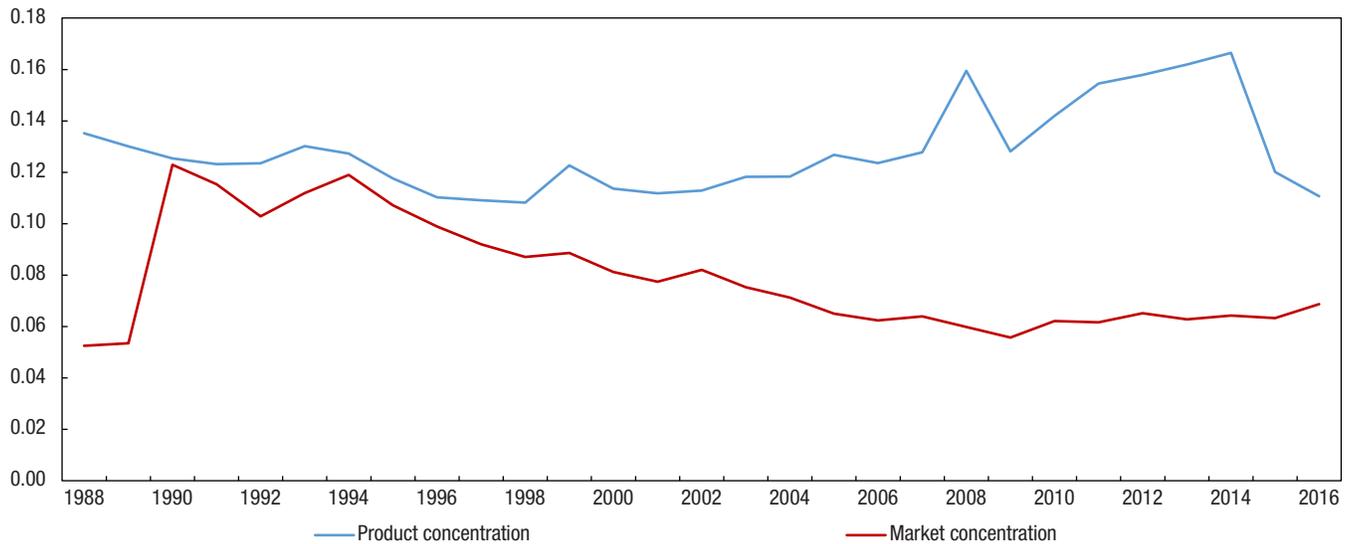
Herfindahl-Hirschman index (HHI)

Note: Important thresholds: Diversified exports where HHI is less than 0.15, moderately concentrated exports where HHI is 0.15 or greater and less than 0.25, highly concentrated exports where HHI is 0.25 or greater.
Sources: Statistics Canada, Canadian International Merchandise Trade Program.

Major non-U.S. partners: product diversification

Among Canada's trading partners other than the United States, China, the United Kingdom, Japan and Mexico were, respectively, the top destination markets of Canadian products in 2016, accounting for 11.7% of total exports that same year.

Since 1997, exports to those non-U.S. countries, with the exception of the United United Kingdom were diversified, with no particular concentration in any commodity, as given by a Herfindahl-Hirschman index of less than 0.15 throughout the entire time period.

Chart 11
Exports to China, Japan, Mexico and the United Kingdom: Canadian export concentration, product
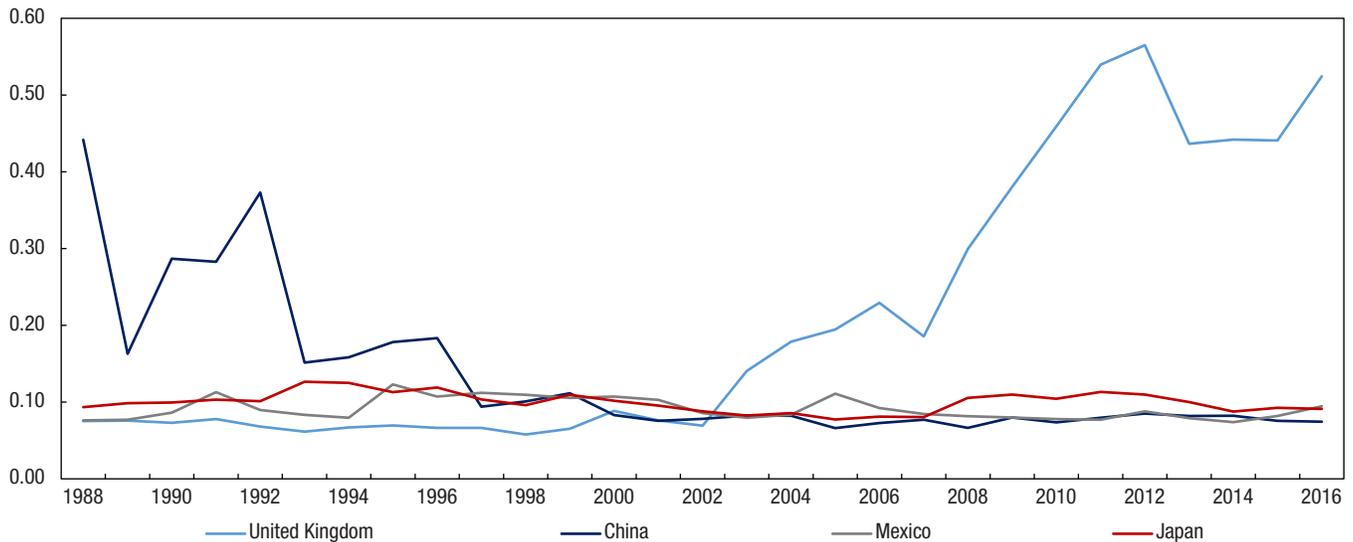
Herfindahl-Hirschman index (HHI)

Note: Important thresholds: Diversified exports where HHI is less than 0.15, moderately concentrated exports where HHI is 0.15 or greater and less than 0.25, highly concentrated exports where HHI is 0.25 or greater.
Source: Statistics Canada, Canadian International Merchandise Trade Program.

The diversification pattern of exports to the United Kingdom has changed over time. Prior to 2004, commodities sent to the United Kingdom were diversified (average Herfindahl-Hirschman index of 0.08) but became highly concentrated thereafter, to reach a Herfindahl-Hirschman index of 0.52 in 2016. One commodity grouping, namely natural or cultured pearls, precious stones and metals, coins (mostly gold), was behind the rising product concentration level, with its share of total exports to United Kingdom in 2016 (72.0%) more than doubling compared with 2003 (33.0%).

Conclusion

A concentration index known as the Herfindahl-Hirschman index has been used as an inverse measure of the diversification of Canadian exports, using customs-based domestic export data going from 1988 to 2016. The evolution of export concentration levels over time has also been examined through an index of the index. Diversification, as it pertains to Canadian exports, has been measured at both the product and geographic levels. This study has resulted in a number of key findings concerning Canadian exports, namely:

- The range of goods exported by Canada is wide, with sufficient distribution among commodity groupings to result in a designation of diversified for the portfolio of Canadian exports. However, when compared to other G7 members, Canada is the least diversified in terms of commodities.

- Product diversification was also examined at the provincial level. Among Canadian provinces and territories, only Quebec and Manitoba had a diversified basket of commodities throughout the entire period ranging from 1988 and 2016. Provinces such as Alberta, Newfoundland and Labrador as well as the Northwest Territories were highly concentrated into few products. For the remaining provinces and territories, different product diversification levels were observed over time.

- In terms of markets of destination, Canadian exports were highly concentrated into a single market, the United States, whose share represented over three-quarters of total Canadian domestic exports in 2016. Among non-U.S. countries, Canada's export markets were diversified. Market concentration levels increased over the period following the signing of Canada's trade agreements with the United States (the Canada-United States Free Trade Agreement as well as the North American Free Trade Agreement) but declined with Canada's increased trade with new markets in Europe and Asia, between 2002 and 2011.

- Looking at the provinces of production, Canadian exports were highly concentrated in Ontario for the period prior to the global financial crisis (2008-09) as well as in 2016. However, as of 2009, Ontario's share of total domestic exports declined while Alberta's was on the rise, thus leading to exports being moderately concentrated within the two provinces.

- Exports sent to the United States were, for most of the period of study, diversified by product and so were the U.S. states they were sent to. Looking at Canada's non-U.S. major trading partners, exports sent to China, Japan and Mexico were deemed diversified while the shipments to the United Kingdom were highly concentrated in Natural or cultured pearls, precious stones and metals, coins (mostly gold) since 2004.

The measures of diversification described in this paper serve as high-level indicators of diversification across several relevant dimensions of merchandise exports. These indicators will not capture all of the subtleties influencing the overall levels of diversification, and therefore do not replace more in-depth studies. They do, however, facilitate the monitoring of key measures of diversification over time. Statistics Canada will be publishing measures of diversification by product, by market of destination and by province of production on an annual basis in CANSIM Table 228-0082.

Appendix

Export concentration measures

There are many statistical tools to measure export concentration, ranging from simple descriptive indicators to complex econometric models, with little agreement on which is best. The most commonly used measure of export concentration is **the Concentration Ratio**, discussed later. There are other frequently-used measures such as the Commodity-Specific Cumulative Export Experience Function (CSCEEF), the Absolute Deviation of Country Commodity Shares, and the Commodity Specific Traditionalist Index, to name a few.

Absolute vs. relative concentration of exports

Concentration (also known as Specialization) indices are **inverse measures of diversification** and can be classified in two major groups:

- The first group of concentration indices relates to absolute specialization. With this group of indices, a country would be considered specialized if a small number of commodities exhibit large shares of the country's total exports. The benchmark for the group is a uniform distribution of export shares, which translates into the equal distribution of export shares across all commodities.

- The second group of indices is a measure of relative specialization. These indices focus on the deviation of a country's export structure from the average world structure of the reference group of countries. The benchmark is the average degree of specialization of countries under study; indices provide data on the dissimilarity in the export portfolio composition of each country compared with the average structure of the selected reference level.

To put the above into context, if exports of a country are concentrated in commodities (product concentration) which other countries are also specialized in, the first group of indices (absolute specialization) will indicate high concentration while the second group will show a low degree of concentration.

Two indices, in particular, fall within the category of relative specialization measures, and will be briefly discussed next, the absolute deviation of the country commodity shares, and the Theil index.

- The absolute deviation of the country commodity shares, also known as a modified Finger-Kreinin measure of similarity in trade, is widely used by the United Nations Conference on Trade and Development (UNCTAD) and indicates whether a country's export structure by product differs from the world pattern. It can be obtained from the following formula:

$$S_j = \frac{\sum_i |h_{ij} - h_i|}{2}$$

where,

h_{ij} is the share of commodity i in total exports of a country j,

h_i is the share of commodity i in world exports.

The value of this index ranges from 0 (no divergence from the world pattern) to 1 (greater divergence from the world structure). The UNCTAD publishes a series of this index for numerous countries through their product named Merchandise: Product concentration and diversification indices by economy, annual, 1995-2015. For information, the export diversification index for Canada, as given by the absolute deviation of the country's commodity shares, has consistently been over 0.3 for the period 1997 to 2015.

- The Theil index has been widely used as a measure of overall inequality and is a special case of the set of inequality measures called the Generalized Entropy Measures. This index possesses the additive decomposability property which is useful for simultaneously studying different aspects of inequality (the extent of either a between-group inequality, a within-group inequality or a group-specific inequality) in a society divided into mutually exclusive and completely exhaustive social groups (e.g., based on gender, race, religion, etc.). Its focus is on differences between interregional and/or international specialization patterns since this index is the only one that possesses the decomposability property. It is best suited to study the economic development of countries where large interregional differences are found.

As the focus of absolute measures differs from that of relative measures, and since this paper is focused more on the degree of diversification (or lack of) of Canadian exports and how the latter changes over time, regardless of the development in other countries, the choice of concentration index will be drawn from the absolute specialization indices.

Concentration ratio

Within the family of absolute specialization indices, there are several measures that have been developed to estimate concentration ratios. These include, among others, the Hirschman index, the Ogive index, the entropy index, the Herfindahl index and the Herfindahl-Hirschman index (HHI).

All these measures are conceptually quite similar, and their approaches compare actual distributions to a hypothetical uniform distribution. We will look at three of the most used concentration ratios next.

- The Hirschman Index is a measure of trade and commodity concentration. It is the index that would result if a country's export receipts were divided evenly among different commodities. It may be written as follows:

$$H_1 = \sqrt{\sum_{i=1}^{N}\left(\frac{x_i}{X}\right)^2}$$

where,

x_i is the export value of a specific commodity i,

X is the country's total exports.

A higher H_1 indicates greater concentration of exports on a few commodities.

- The Herfindahl index, commonly used for measuring industrial concentration is a method of summarizing the degree to which an industry is oligopolistic and the concentration of market control held by the largest firm in the industry. The formula used is the following:

$$H_2 = \sum_{i=1}^{N}\left(S_i^2\right)$$

where,
S_i is the market share of the ith firm.

The Herfindahl index is quite similar to the Hirschman index except for the square root, and is sometimes referred to in some modified forms as the Hirschman index.

- The Herfindahl-Hirschman index (HHI) is the most commonly used statistic for measuring concentration and sums the squared shares of each commodity in total exports. This index is a modified version of the Herfindahl index of industrial concentration, and can be expressed as follows:

$$HHI = \sum_{i=1}^{N} \left(\frac{x_i}{X}\right)^2$$

where,

X is the country's total exports, and

N is the total number of export products.

The index has specific bounds with its range varying between a lower bound of $1/N$ and a maximum of 1. Lower values of HHI indicate a more uniform distribution of exports among a series of products (or diversified markets in case of geographic concentration) whereas higher values reveal a high degree of concentration (of exported products or markets destination) or equivalently, a less diversified export portfolio.

Characteristics of a good concentration index

In order to assess the validity of the Herfindahl-Hirschman index as an inverse measure of export diversification, its characteristics were put to the test and they passed the following six axioms:

- **Axiom of Anonymity.** The level of concentration should not be impacted by a re-ordering (permutation) of export shares of commodities (or markets) used in the calculation of the concentration index.

- **Axiom of Progressive Transfers.** A country should become less concentrated if part of the value of exports were to be transferred from a commodity (trading partner) that this country is more strongly concentrated in, towards a commodity (trading partner) that this country is less concentrated in, as long as the transfer between the two commodities (trading partners) does not reverse the ranking of these two.

- **Bounds.** In order to put concentration levels into perspective, it is important to define clear bounds. The upper bound, which implies complete concentration, is reached if a country's export receipts come solely from one commodity or if they are sold to one single trading partner, with the other commodities (trading partners) having a share of 0 in total exports. In that case, the concentration index upper bound would be equal to 1. The lower bound, on the other hand, means total diversification or total equality of export shares among commodities (or trading partners). If there are N commodities (or trading partners), the lower bound would then be equal to 1/N.

- **Decomposability.** A good index should allow us to distinguish characteristics that are inherent to the whole country from those that are specific to some regions compared to the national level (the within-country component). Thus, if a country is concentrated in the export of a specific commodity, a concentration index at the provincial level may reveal a different scenario for one or more provinces.

- **Classification of commodities.** Concentration levels should be affected by the grouping of commodities into larger classes (or inversely, the splitting of larger classes into sub-groups of commodities). Ideally, if we split a group of commodities into two sub-groups, the level of concentration should decrease, since each group now has a smaller share. This implies that changes in the commodity groupings should influence the concentration levels.

- **Number of commodities.** The introduction of a new product with an export share of zero or a very small export share should have negligible impact on the level of concentration given by the index.

Product concentration using real export data

This analysis makes use of nominal export values in the calculation of the concentration index, which makes the latter sensitive to fluctuations in commodity prices. Chart 12 presents the Herfindahl-Hirschman index measured using both real and nominal export values, aggregated using the North American Product Classification System groupings (NAPCS), at the commodity's group level:

Chart 12
Canadian export concentration (product), derived from real and nominal export data

Herfindahl-Hirschman index (HHI)
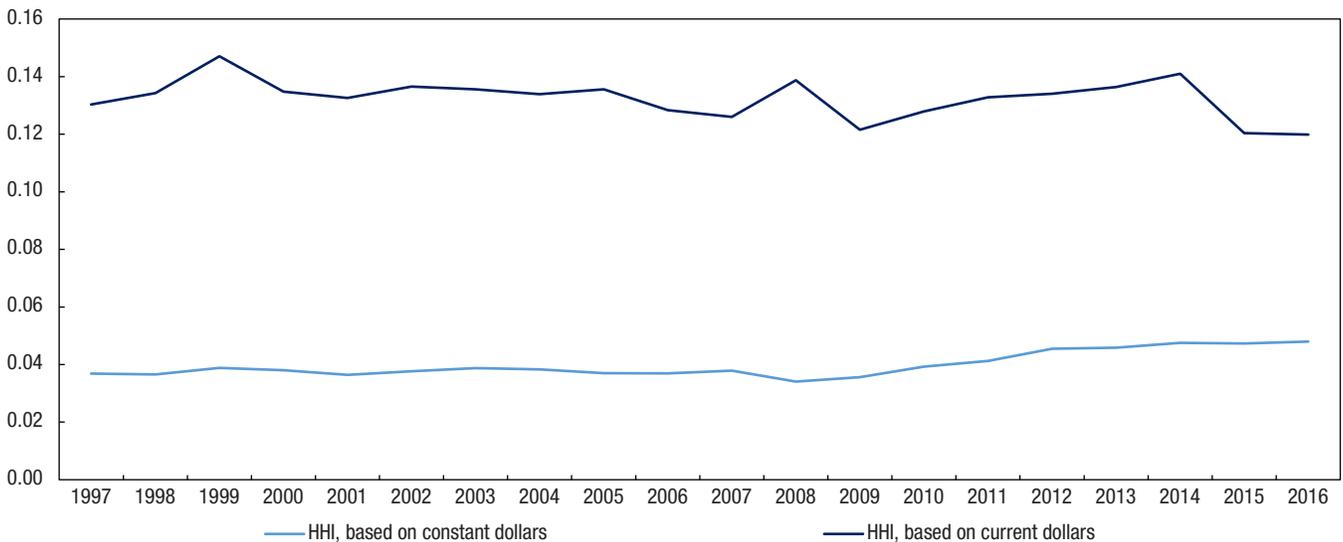
Note: Important thresholds: Diversified exports where HHI is less than 0.15, moderately concentrated exports where HHI is 0.15 or greater and less than 0.25, highly concentrated exports where HHI is 0.25 or greater.
Source: Statistics Canada, CANSIM Table 228-0082 and the Canadian International Merchandise Trade Program.

As shown in Chart 12, although Canadian exports were deemed diversified using both real and nominal export data, deflated values led to increased diversification of Canadian exports as can be seen from the significant lower concentration levels obtained from export volume data (consistently below 0.07). In nominal terms, crude oil was behind most of the increased concentration levels observed from 2010 to 2015 when crude oil prices rose significantly. In real terms, the share of crude oil in total export volume went from 10.2% in 2008 to 17.1% in 2016, thus also accounting for the increased product concentration over that time period.