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ISSUE REPORT

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Assessing the Market and Trade Impacts of Canada's Proposed Plastic Packaging Restrictions

In August 2023, Environmental and Climate Change Canada (ECCC) issued a pre-proposal notice to phase out plastic packaging for fresh produce. The proposal seeks to achieve up to 75% of fresh produce sold in major retailers in Canada using bulk or non-plastic packaging by 2026, increasing to 95% by 2028. An often-overlooked reality of environmental regulations, even if well-intentioned, is the significant economic toll on consumers and the potential disruption of cross-border trade. These concerns are exacerbated due to the absence of fully established alternative packaging solutions that reliably ensure

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About this Issue Report

This Farm Foundation Issue Report evaluates the economic implications of Environmental and Climate Change Canada's proposed plastic packaging restrictions for retail prices and per capita fresh fruit and vegetable availability for Canadian consumers under alternative import supply reduction scenarios.

comparable quality, freshness, and food safety for consumers. For Canada, a country that straddles temperate and subarctic climate zones, imports of fresh fruits and vegetables make up an outsized share of domestic availability on supermarket shelves.

We evaluate the economic implications of the ECCC's proposed plastic packaging restrictions for retail prices and per capita fresh fruit and vegetable availability for Canadian consumers under alternative import supply reduction scenarios. We begin by reviewing U.S. exports of fresh fruits and vegetables and the importance of the Canadian market, followed by a closer look at the share of imports of fresh fruits and vegetables in Canada's total availability from domestic and imported sources. Finally, we summarize the market impacts on Canadian retail prices and per capita availability of fresh produce and the likely economic burden on households in Canada if the ECCC's restrictions on plastic packaging entered into force.

Background

International trade of agricultural products has lifted millions of people out of poverty, increased food availability for the undernourished, enhanced competitiveness and affordability, and improved the livelihoods of many.[1] The United States is one of the largest producers and exporters of food and agricultural products. Thus, international trade is vital to the prosperity of agricultural producers who depend on exporting to support farm incomes and diversify their customer base. Through trade, producers gain access to foreign markets which allows them to lower average costs and expand sales at competitive international prices. Consumers in foreign countries gain access to products year-round that may not otherwise be available in the absence of trade due to differing seasonal and climatic conditions. An often forgotten, yet important, benefit of agricultural trade is its critical role in linking regions with food surpluses to regions with food deficits, thereby fostering resiliency in the global food system and ensuring access and availability to nutrient-rich foods such as fresh fruits and vegetables, seafood, meat, and dairy products.

On January 1, 2024, the (former) North American Free Trade Agreement (NAFTA) between the United States, Canada and Mexico celebrated its 30th anniversary. Over a 15-year period, NAFTA members began a series of reforms that effectively removed most barriers to agricultural trade and solidified the integration of North American supply chains.[2] Twenty-five years later, on July 1, 2020, NAFTA was re-negotiated and updated to become the United States-Mexico-Canada Agreement (USMCA).[3] Since 1995, U.S. exports have increased over three-fold from $62.3 billion in 1995 to a record $196 billion in 2022. The significance of USMCA/NAFTA members for U.S. agricultural exports is stark; in 1995, just 15%, or $9.4 billion of U.S. agricultural exports were sent to Canada and Mexico. Seven years later, in 2002, that share doubled to nearly 30% and has remained between 27% and 31% since then. This means that nearly one-third of U.S. food and agricultural exports continue to be sold in North America. This highly integrated, regionally focused supply chain is one of the most dynamic food systems globally, feeding a wealthy

population with a robust set of safe and nutritious food choices throughout the year.

Environmental Regulations, Even When Well-Intentioned, Can Be a Double-Edged Sword for Cross-Border Trade

However, technical barriers to trade, including measures to promote environmental sustainability, can disrupt these trade outcomes. This is particularly true for North American trade in horticultural products where significant cross-border movements of fresh fruits, vegetables, and tree nuts are optimized for different climate zones, growing seasons, and regional comparative advantages. On April 18, 2023, Environment and Climate Change Canada (ECCC) published a framework paper on recycled content and labeling rules for plastics. The report outlined targets for reducing plastic pollution.[4] In August 2023, ECCC published a consultation document: pollution prevention planning notice (P2) for plastic food packaging to further address plastic waste and pollution.[5,6] The proposed packaging regulations set ambitious environmental goals by requiring large Canadian grocery retailers, defined in the notice as retailers that generate grocery retail sales in Canada over $4 billion annually, to formulate and apply a pollution prevention plan to meet reuse and recycle targets by eliminating unnecessary packaging, displacing single-use packaging with reuse-refill systems, and providing food-safe plastics designed to be reused, recycled, and composted in Canadian facilities.

A summary of the specific targets of the P2 Notice include (pg. 9):

1) *"Reducing the environmental impact of primary food plastic packaging along the value chain … by 2035."*
2) *"75% of fresh fruits and vegetables shall be sold in bulk and/or plastic-free packaging by 2026, and 95% by 2028."*
3) *"All primary food plastic packaging is to be reusable, recyclable, or compostable by 2028."*
4) *"Develop strategies, outside of fresh produce, to enhance sales … within a reuse-refill system, products free of plastic packaging, and/or concentrated products by 20% by 2026, 50% by 2030, and 60% by 2035."*
5) *"Non-reusable plastic food packaging to contain post-consumer recycled content of 10% by 2028, 20% by 2030, and 30% by 2035."*

However, the intent to further reduce plastic waste through presumed environmental benefits invites serious economic and affordability implications for everyday Canadian consumers. As discussed shortly, this is because over 75% of Canada's total availability

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of fresh fruits and tree nuts, and over 60% of fresh vegetable supply is imported, primarily from the United States. With such a large reliance on imports by a country that straddles temperate and subarctic climate zones, it is surprising that Canada would unilaterally propose such ambitious targets to phase out single-use plastic packaging when alternative technology that ensures the same level of quality, safety, affordability, and convenience does not yet readily exist.

In this short article, we evaluate the economic implications of the ECCC's proposed plastic packaging restrictions for retail prices and per capita fresh fruit and vegetable availability for Canadian consumers under alternative import supply reduction scenarios. Specifically, we assess three scenarios in which the supply of fresh produce imports into Canada is reduced by 25% (low-impact), 50% (moderate-impact), and 62% (high-impact), assuming North American supply chains and industry packaging and distribution companies will be unable to adapt to *reusable, recyclable, or compostable* packaging materials, or are unable or unwilling to export fresh produce in bulk or non-plastic to serve the Canadian market. We begin by reviewing U.S. exports of fresh fruits and vegetables and the importance of USMCA/NAFTA partners. This is followed by a closer look at the share of imports of specific fresh fruits and vegetables in the Canadian market. Here, we map import quantities from the U.S. and other countries with domestic production and availability data within Canada to summarize the dependency on imports for consumers in Canada. Finally, we discuss the results from import supply shocks using an equilibrium displacement model of fresh fruits and vegetables that might represent probable market impacts on retail prices and per capita availability and the economic burden on households in Canada.

Evidence From Recent Studies

Plastic packaging is a ubiquitous feature of fresh fruit and vegetable trade that ensures product safety, quality, integrity, and affordability. Retailers prefer fresh produce to be packaged for several reasons:

1) ***Protection:*** *packaging protects fresh produce from damage during transportation and on retail shelves.*
2) ***Extended shelf-life:*** *innovative package designs maintain optimal temperature, circulation of nitrogen and oxygen, and humidity levels. For highly perishable products, package design minimizes pathogens, contaminants, and spoilage, and is particularly important to rural communities, who face accessibility challenges for fresh produce.*
3) ***Convenience and affordability:*** *fresh produce wrapped or packaged is often pre-washed and pre-cut or peeled, reducing the opportunity cost of consumer time at home spent prepping and adding to the overall economic affordability and accessibility for households.*

Relatively few studies have analyzed the trade and economic implications of the ECCC's pollution prevention plan. In a recent study by Value Chain Management International, Inc. (VCMI), Canada's proposed reduced plastic packaging requirements could increase food loss and waste by 495,000 metric tons and result in financial losses for the fresh produce industry of $3.4 billion.[7] VCMI respondents

indicated approximately 64% of the total volume (tonnage basis) across 20 produce categories were sold in single-use plastics (SUP), up from 60% in 2019. *Brandenburg and Vandercook (2023)*[8] found that value-added produce supports jobs and generates a $1.3 billion economic impact. In addition, according to various industry expert interviews, *Brandenburg and Vandercook (2023)* report that in the absence of breathable plastic packaging, fresh-cut produce has at best 1–2 days of marketable shelf-life due primarily to rapid dehydration, compared to 10–15 days of remaining shelf-life with optimal packaging.

Kasza et al., (2022)[9] find that measures aimed to promote environmentally sustainable consumption patterns may compromise food safety. Expert opinions clearly indicated that a significant part of environmentally conscious measures contribute to food safety risks including mold, eating expired perishable food, overstoring leftovers, cross-contamination attempting to avoid single-use plastic packaging, and using reusable bags without properly cleaning and storing these items over long periods of time. *White and Lockyer (2020)*[10] echoed this sentiment, noting that the resulting reduction in shelf life of fresh produce when removing plastic packaging will lead to significant food waste. Moreover, food waste generates greenhouse gases. *Buzby (2022)*[11] estimates that food waste makes up one-third of all food destined for human consumption, and food waste that ends up in landfills generates methane—an even more potent greenhouse gas than CO_2.

In a 2023 study using survey data from Abacus Data Inc.[12] of 1,500 adults over the October 16–22 period,

the Canadian Produce Marketing Association *(CPMA, 2023)*[13] found that among adult Canadians surveyed, increasing cost of living was more of a concern than the plastic packaging of fresh produce. In three out of five (or 60%) of Canadian adults, rising costs of living, not plastic packaging of fresh produce, was "top-of-mind" when shopping for fresh produce, despite claims by Canada's ECCC Minister that the federal government has "… heard from coast to coast that they [Canadians] hate seeing so much plastic wrapping."[14] Further, as a result of rising costs, only one in three Canadians has increased fresh fruit and vegetable consumption compared to two years ago, with nine out of ten noting that it has become more expensive. The mean weekly cost of buying fresh produce was nearly $60 per household. Their findings also underscored the general lack of awareness of the ECCC's plan to eliminate 95% of plastic packaging in retail grocers by 2028. Fewer than one in three Canadians surveyed acknowledged that they were aware of the federal initiative.

A study by *Deloitte (2023)*[15] finds that prices could increase 34% when shifting to the ECCC's proposed

P2 regulation. In a sensitivity analysis, where only 60% of the estimated operational cost increases are passed through to retail markets, consumer prices increased by 20%.

Considering monthly food inflation in Canada relative to the same month in the previous year has increased by over 5% since November 2021, further disruptions due to the elimination of plastic packaging of fresh produce could jeopardize nutritional access and availability for all consumers of this important food group.[16]

In a report by the Standing Committee on Environment and Sustainable Development to the House of Commons, Canada *(Scarpaleggia, 2022),*[17] the Committee noted that the manufacturing of plastic products in Canada was worth an estimated $35 billion in 2017, representing approximately 5% of sales in the Canadian manufacturing sector, and employing 93,000 jobs in just under 2,000 firms. It also heard that the annual value of SUP sales in Canada is $5.5–$7.5 billion. The Committee heard testimonies about the linear (plastic) economy or "make, take and toss"; that most plastic package is used once and discarded with limited reuse or recycling which would support a more circular economy. In addition, industry representatives noted that the problem "isn't single-use plastics," it's the "single use of plastic that's the problem." They argued that the Canadian government should focus its attention and resources on measures that improve the management of plastic waste, including through increased recycling.

In summary, ECCC's proposal to require fresh fruits and vegetables be sold in bulk and/or plastic-free packaging without a viable alternative is likely to be costly and challenging for the fresh produce industry to implement. According to early evidence reviewed here, it will almost certainly increase the price of most fresh produce, generate more food loss and waste, greenhouse gas emissions, food safety risks, and reduce affordability among consumers. Without plastic packaging, increased sales of fresh produce in bulk become especially vulnerable to harmful pathogens such as *E. coli, Salmonella,* and *Listeria,* particularly for products that are pre-cut or trimmed. *Brandenburg and Vandercook (2023)* state: "As of now, there is no alternative to plastic modified atmosphere packaging; elimination of plastic primary packaging produce would result in the inability of the industry to provide 100% of the current value-added produce product assortment sold in the Canadian market."

U.S. Exports & the Market for Fresh Fruits and Vegetables in Canada

In 2022, the U.S. was the largest global exporter of tree nuts, fourth largest exporter of fresh vegetables, and sixth largest exporter of fresh fruits, serving over 175 countries. Trade liberalization under USMCA/NAFTA and the harmonization of phytosanitary issues have led to significant integration of North America's fruit and vegetable markets.[18] By creating new export opportunities and capitalizing on comparative advantages dictated by climate, geography, and an integrated supply-chain network, Canada is the U.S.'s most important trading partner for fresh fruits and vegetables.

Table 1 illustrates this integration by comparing the value of select product categories of U.S. fresh fruit,

tree nuts, and fresh vegetable exports to Canada in 1995 compared to 2022, the average annual growth rate of U.S. exports to Canada, U.S. world exports, and the share of U.S. exports sent to Canada. Seven fresh fruits and vegetables and four tree nut categories are illustrated. U.S. fresh fruit and vegetable exports to Canada have experienced substantial growth since 1995, reflecting a robust trade relationship between the two countries. From 1995 to 2022, U.S. fresh fruit exports to Canada increased from $587 million to $1.7 billion, with an average annual growth rate of 4%. Concurrently, U.S. fresh vegetable exports to Canada rose from $711 million to nearly $2.2 billion during the same period, with an average annual growth rate of 5%. The upward trend is also notable in U.S. tree nut exports to Canada, which increased from $129 million in 1995 to $772 million in 2022, reflecting an average annual growth rate of 7%.

Among individual produce categories, fresh lettuce and strawberries are the largest exports from the U.S.

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Table 1. U.S. Exports of Fresh Fruits, Vegetables, and Tree Nuts to Canada and World, 1995 vs. 2022

	Annual Exports to Canada 1995	Annual Exports to Canada 2022	Annualized Compound Growth Rate	U.S. Global Exports in 2022	Share of U.S. Exports Sent to Canada
	$ Mil.	$ Mil.	(%)	$ Mil.	(%)
Fresh Fruit, excl. juice	**587**	**1,716**	**4%**	**4,090**	**42%**
Strawberries, fresh	51	347	7%	496	70%
Grapes, fresh	117	204	2%	636	32%
Apples, fresh	61	203	5%	876	23%
Raspberries, blackberries, mulberries, and loganberries, fresh	5	136	13%	159	86%
Blueberries, fresh	10	125	10%	143	87%
Cherries, fresh	15	122	8%	329	37%
Oranges, fresh or dried	87	109	1%	489	22%
Tree Nuts (in shell or shelled)	**129**	**772**	**7%**	**9,101**	**8%**
Almonds, fresh or dried	32	153	6%	4,511	3%
Walnuts, fresh or dried	11	67	7%	1,289	5%
Pecans, fresh or dried	19	57	4%	309	18%
Pistachios, prepared or preserved	3	14	6%	1,797	1%
Fresh Vegetables, excl. juice	**711**	**2,148**	**5%**	**2,653**	**81%**
Lettuce, fresh	137	533	5%	619	86%
Cauliflower and broccoli, fresh	29	200	7%	218	92%
Onions and shallots, fresh	44	187	6%	264	71%
Tomatoes, fresh	98	120	1%	128	94%
Spinach, fresh or chilled	11	105	9%	133	79%
Carrots, fresh	37	100	4%	112	89%
Other	350	748	3%	1,179	69%
Grand Total	**1,427**	**4,636**	**4%**	**15,844**	**29%**

Source: Author's calculations from the Foreign Agricultural Service's (FAS) Global Agricultural Trading System (GATS), available at: https://apps.fas.usda.gov/gats/default.aspx?publish=1.

**Note: sector sub-totals for Fresh Fruit, excl. juice., Tree Nuts (in shell or shelled), and Fresh Vegetables, excl. juice are for all products in these sectors, not just those illustrated here.*

to Canada, valued at $533 million and $347 million, respectively, in 2022. Both products exhibited significant average annual growth rates of 5% and 7%, respectively. Other noteworthy exports from the U.S. to Canada exceeding $200 million in 2022 include fresh grapes ($204 million), apples ($203 million), and cauliflower and broccoli ($200 million).

On a global scale, U.S. tree nuts exports in 2022 reached $9.1 billion, followed by U.S. fresh fruit exports at $4.1 billion, and fresh vegetable exports at $2.7 billion. The importance of the Canadian market for U.S. fresh produce exports is clearly evident: in 2022, 42% of fresh fruit and a remarkable 81% of U.S. fresh vegetable exports were sold to customers in Canada **(Table 1)**.

At the individual product level, the share of U.S. fresh produce exports to Canada varies widely. For fresh fruits, a substantial portion of U.S. raspberries (86%), blueberries (87%), and strawberries (70%) are exported to Canada. In contrast, fresh oranges, apples, and grapes have lower export shares to Canada at 22%, 23%, and 32%, respectively. U.S. fresh vegetable exports to Canada exhibit a larger share across the board, with fresh tomatoes having the highest export share at 94%, followed by cauliflower and broccoli at 92%, and carrots at 89%. Even for the lowest fresh vegetable export share—other vegetables not elsewhere specified (i.e., sweet corn, olives, artichokes, pumpkins, etc.)—the share of U.S. exports to Canada is a still considerable 69%. Among tree nuts, pecans hold the largest share of U.S. exports to Canada, accounting for 18% of U.S. total pecan exports.

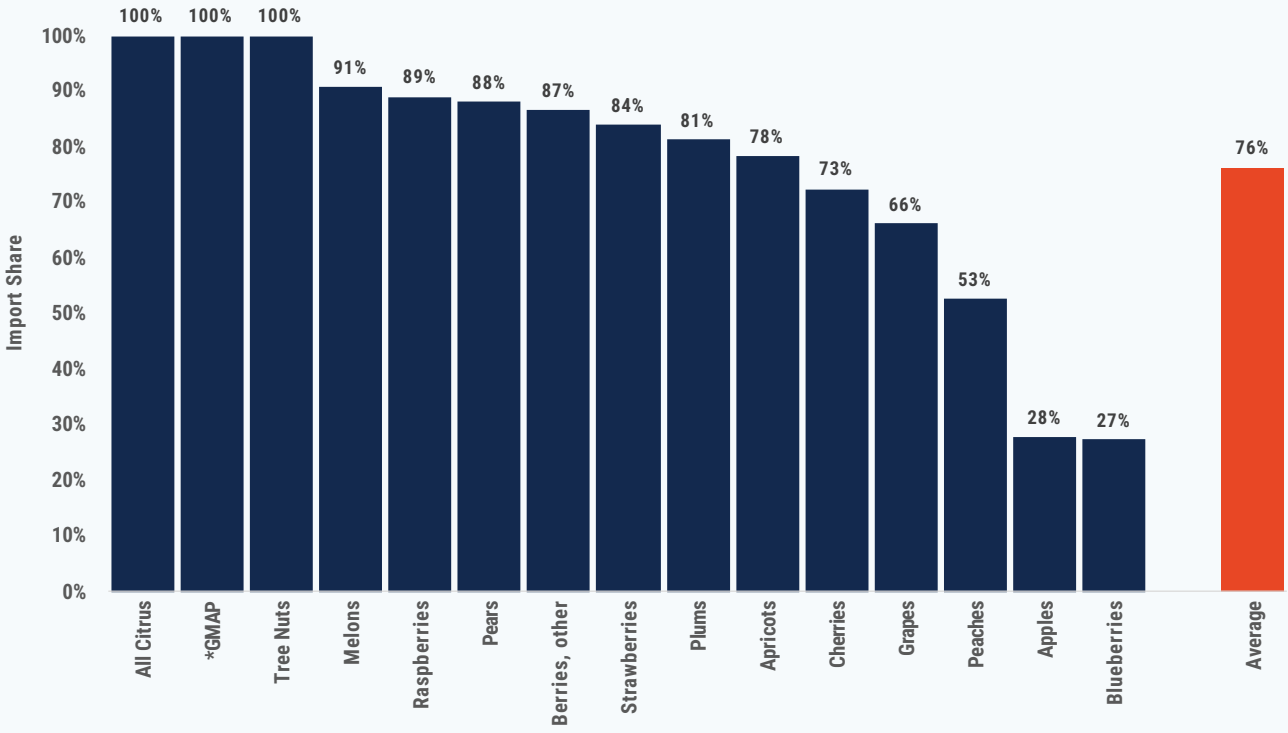
The figures in **Table 1** underscore the importance of the Canadian market for U.S. fresh fruit and vegetable export sales across numerous product segments. It also illustrates the significant growth of U.S. fresh fruit and vegetable exports to Canada since 1995. However, the results in **Table 1** do not tell us how important U.S. exports are in fresh fruit and vegetable imports into Canada. For example, while 87% of fresh blueberry exports from the U.S. went to Canada in 2022, this is not a sufficient condition guaranteeing that Canada has a high reliance on fresh blueberry imports from the U.S. to satisfy its domestic consumption needs. To get a better sense of Canada's import reliance, we need to combine data on Canada's total imports, its imports from the U.S., and the availability of fresh produce from its own (domestic) production. In what follows, we take a closer look at the supply-use balance in Canada. This will also help inform the price impact assessment of the ECCC's proposal to restrict fresh produce to be sold in bulk and/or plastic-free packaging.

The Importance of Canadian Fresh Fruit and Vegetable Imports in Domestic Availability

Given Canada's temperate and subarctic climate, imports of many fresh fruits and vegetables are an important component to satisfy total domestic demand. To get a better sense of "how important" imports are, this subsection presents a graphical summary of the share of Canada's imports of fresh produce in total domestic availability.

Figure 1 plots these shares for select categories of fresh fruits, and an aggregate tree nuts category. Total domestic availability is equal to domestic production plus imports minus waste for those products where reliable data exist.[19] **Figure 2** plots the share of Canadian fresh vegetable imports in total domestic availability. Fifteen categories of fresh fruits and 17 fresh vegetable products are depicted in **Figures 1 and 2**, respectively. Also illustrated is the average import share across all categories considered. Several important trends are worth highlighting.

Figure 1. Share of Imported Fresh Fruit Products in Total Domestic Availability in Canada, 2022



Source: Author's calculations from Statistics Canada Tables and Trade Data Monitor.

**Note: All Citrus includes oranges, mandarins, tangerines, grapefruit, lemons, and limes. GMAP is an acronym denoting a combined category of Guavas (G), Mangoes (M), Avocados (A), and Pineapples (P). We combine these categories of fruits because there is no domestic production within Canada (i.e., most tropical products cannot be grown in temperate climates). The bar labeled "Average" is the mean share of imports in Canada's total domestic availability across all fresh fruit products illustrated.*

With the exception of blueberries and apples, imports of fresh fruits in Canada make up over 50 percent of domestic availability. For fresh blueberries, we can contrast the import share in **Figure 1** with the U.S. export share of blueberries exported to Canada in **Table 1**. Although 87% of U.S. blueberry exports are sent to Canada **(Table 1)**, Canada also produces significant amounts of domestic blueberries.[20] Thus, imports from all sources contributed to a smaller 27% of overall domestic availability. This highlights the importance of including domestic production in addition to imports for a more complete picture of a country's import dependence.

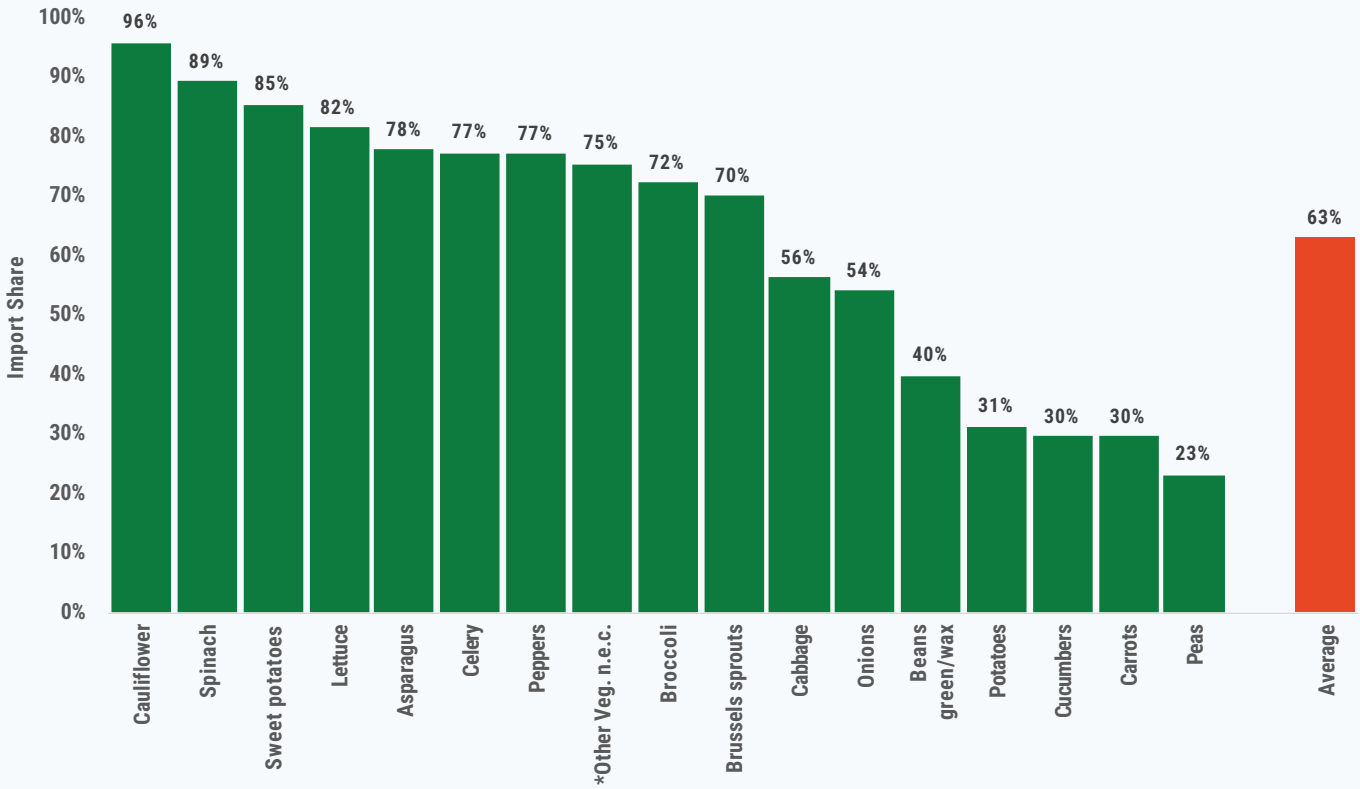
On the other hand, for most tropical and sub-tropical products such as citrus (All Citrus, **Figure 1**), guavas, mangoes, avocados, and pineapples (collectively GMAP), and tree nuts, imports equate to 100% of domestic availability in Canada. For all other products where there is some (measurable) domestic production, imports still represent a sizeable share of fresh fruits available for retail sale (or further processing). For example, at the low end of this range are peaches (grown mostly in southern Ontario and British Columbia) at 53%, whereas Canadian imports of melons (watermelons, cantaloupe, and honeydew) make up 91% of domestic availability. The average import share of total fresh fruit availability in Canada is stark and equal to 76% across all products considered in 2022.

Figure 2 examines the importance of Canada's imports of fresh vegetables in its overall domestic availability. Here, we represent 17 imported fresh

vegetable categories matched to data on domestic production and use.[21] For fresh vegetables, five products recorded import shares of total domestic availability in Canada of less than 50%: green and wax beans, potatoes, cucumbers, carrots, and peas. For these products, the import share of domestic availability ranges between 23% for peas to 40% for beans. Thus, for these products, Canada is less reliant on imports, and disruptions to imports from phasing out SUP may not impact domestic prices as much as products with a higher dependency on imports.
For the remaining 12 fresh vegetables depicted in **Figure 2**, the share of imports in domestic availability ranges from 54% and 56% for onions and cabbages to 96% for cauliflower. In fact, for eight, or nearly half of the fresh vegetable products presented in **Figure 1**, Canada's reliance on imports to satisfy domestic demand is more than 75% (cauliflower, spinach, sweet potatoes, lettuce, asparagus, celery, peppers, and other fresh vegetables not elsewhere specified).

Comparing **Figures 1 and 2** in terms of the number of products in which Canada's import reliance is greater than 50% suggests that 13 fresh fruits and 12 fresh vegetable products meet this threshold. On average, Canada is 63% and 76% reliant on imports to meet domestic use of fresh vegetables and fruits, respectively.

Figure 2. Share of Imported Fresh Vegetables in Total Domestic Availability in Canada, 2022



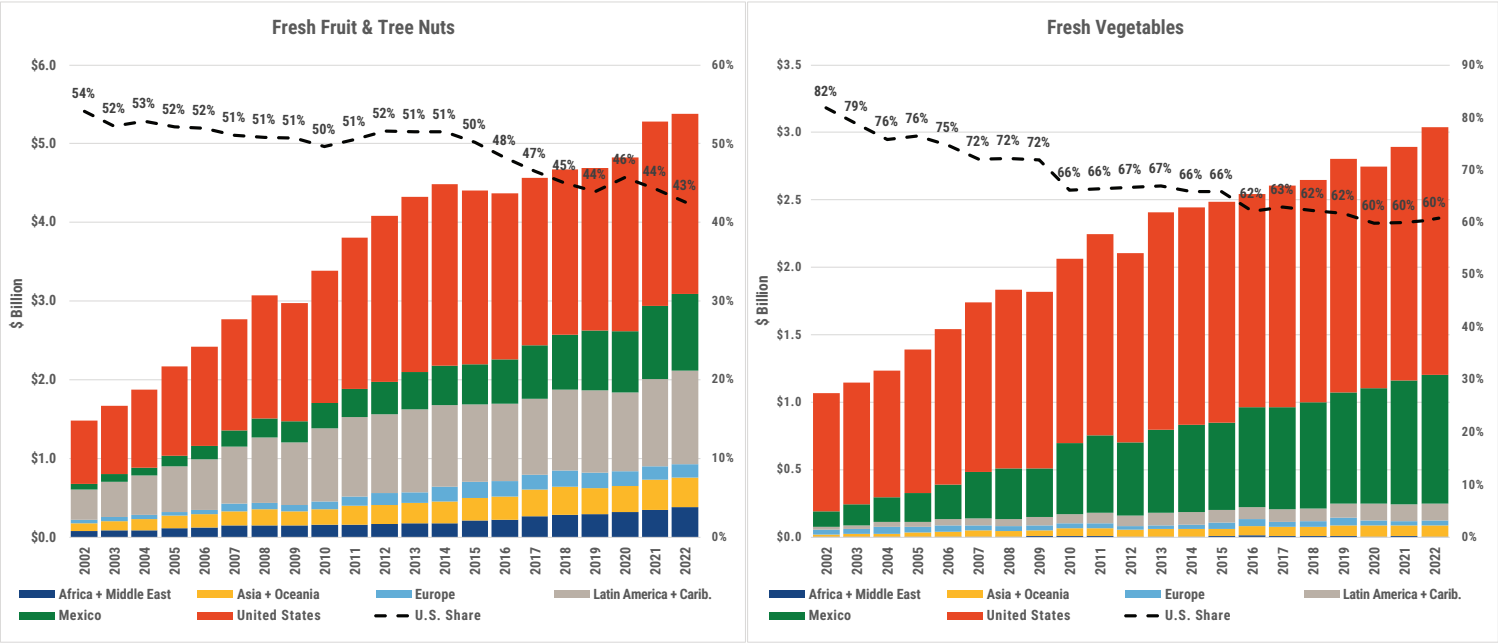
Source: Author's calculations from Statistics Canada Tables and Trade Data Monitor.

**Note: The bar labeled "Average" is the mean share of imports in Canada's total domestic availability across all fresh vegetable products illustrated.*

Finally, **Figure 3** provides a closer examination of the importance of Canada's imports and the significant role played by the U.S. as an export supplier in each sector. The left panel of **Figure 3** focuses on Canadian imports of fresh fruits and tree nuts, while the right panel depicts Canadian fresh vegetable imports. With the exception of the U.S. and Mexico who are depicted individually, all other countries contributing to Canada's imports are aggregated into four regions in **Figure 3:** Africa and the Middle East, Asia plus Oceania, Europe, and Latin American and the Caribbean. Additionally, the U.S. share in Canada's overall imports for each sector is plotted on the secondary vertical axes (dashed line).

In 2022, Canada's imports reached a record $5.2 billion for fresh fruit and $3.0 billion for fresh vegetables. This import growth is striking when compared to 2002, with fresh fruit imports nearly quintupling and fresh vegetable imports tripling. Notably, the U.S. (in red in **Figure 3**) plays a critical role in supplying Canada's fresh fruit and vegetable imports.

Figure 3. Canadian Imports of Fresh Fruits and Vegetables by Region and the Share of Imports Sourced from the United States, 2002–2022



Source: Author's calculations from Trade Data Monitor using Canada's reported import statistics. Tree nuts include almonds, walnuts, pistachios, and pecans—the largest varieties produced and traded in North America.

Two decades ago, 54% of Canada's $1.5 billion fresh fruit imports came from the U.S. The scenario is even more pronounced for fresh vegetables, where 82% were sourced from the U.S. And, while the share of Canada's imports that are sourced from the U.S. has diminished slightly over time, it remains significant, with 43% of fresh fruit and 60% of fresh vegetable imports originating from its southern neighbor in 2022.

Figure 3 also highlights the increasing contribution of Mexico. In 2002, Mexico supplied 5% and 11% of fresh fruit and vegetable imports, respectively. By 2022, these figures rose significantly to 18% and 31%. Combined, the U.S. and Mexico contribute 61% and 92% to Canadian imports of fresh fruits and vegetables, underlining the critical position of these two countries in the Canadian market.

Finally, although not illustrated in **Figure 3**, some individual product comparisons in which Canada's reliance on imports as a share of total domestic availability **(Figures 1 and 2)** is high can be drawn. For instance, Canada relies on imports for 84% of its total strawberry demand, and 77% of these imports are sourced from the U.S. In the fresh vegetable sector, 82% of Canada's total domestic availability of fresh lettuce comes from imports **(Figure 2)**, and 91% of these imports are from the U.S.

Equilibrium Displacement Model and Data

This section describes the methods and data used to forecast potential shocks to retail prices and per capita availability of fresh produce in Canada. The methods assume that the ECCC's P2 Notice will go into effect and impact the availability of fresh fruits and vegetables imports into Canada under a moderate- and high-impact scenario using prevailing market conditions.

Data Used

Bilateral trade values and volumes of Canada's reported imports of fresh fruits, tree nuts, and vegetable products were assembled from Trade Data Monitor.[22] Trade Data Monitor provides trade values and quantities from origin to destination in fresh produce products for over 80 countries and dates back to 1988 for Canada. All of the United States' reported export values and volumes were taken from the USDA's Foreign Agricultural Service Global Agricultural Trading System (FAS/GATS), which reports official U.S. Census exports at the HTS 10-digit level.[23] Fresh fruits, tree nuts, and vegetable products in Chapters 07 and 08 of the Harmonized

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System (HS) of product codes are used to calibrate the equilibrium displacement model and ECCC's proposed SUP packaging restrictions.[24] All underlying data are for 2022 unless otherwise noted.

As discussed previously, the price impact of single-use plastic restrictions for fresh produce depends on several factors, including:

- *The share of imports in domestic availability (also known as the import penetration rate),*
- *Domestic supply and demand for the product considered,*
- *Import demand and domestic supply elasticities, and*
- *The ability of U.S. and other foreign export suppliers, as well as domestic producers, wholesalers, packagers, distributors, and retailers to comply with the ECCC's proposed plastic packaging regulation.*

Production, supply, and domestic use information were collected from Statistics Canada Tables of Supply and Disposition of Food in Canada (various fresh fruits and vegetables, Table 32-10-0053-01).[25] The supply and disposition tables provide information on total supply, which is comprised of beginning stocks, production, and imports, and total demand comprised of domestic disappearance, exports, manufacturing (i.e., further processing), waste, and ending stocks (i.e., carryover stocks). For some products, data were unavailable from Statistics Canada. In these instances, we used production and export information from the Food and Agricultural Organization of the United Nations (FAOSTAT).[26]

World Bank data are used for Canada's population, which stood at 38,929,902 residents in 2022.

Population is used to convert changes in trade volumes resulting from Canada's SUP packaging restrictions to changes in per capita availability of fresh fruit and vegetables.

Retail prices in Canada are downloaded from Statistics Canada's monthly average retail prices for selected products data series in 2022.[27] In certain cases (e.g., broccoli), Statistics Canada did not provide retail prices, or the retail price was illustrated on a generic per-unit basis. In these cases, it was difficult to know *a priori* the exact weight of one unit. Thus, we resorted to online searches of various retail outlets across Canada that listed retail prices and the unit weight for these missing product categories.

Equilibrium Displacement Model of Canada's Proposed Single-Use Plastic Packaging Restrictions

We developed an equilibrium displacement model (EDM) of supply and demand for fresh fruits and vegetable imports and domestic production and use in Canada. The model consists of three export suppliers of fresh produce to the Canadian market—the U.S., Mexico, and rest of the world ("RoW"). EDMs (or market models) use prevailing market conditions such as retail prices and quantities available, combined with demand and supply elasticities to evaluate potential changes in equilibrium prices and quantities due to shocks to supply or demand. Demand for fresh produce categories in Canada is a function of the demand shifters and the elasticity of domestic and import demand. Supply functions are composed of a supply shifter and the elasticity of supply with respect

to price. In equilibrium, supply equals demand, and solving this system for the percentage change in retail prices can be expressed as a function of a ratio of the difference in the supply and demand segment shift parameters over the difference between the elasticities of supply and demand and the share of imports in total domestic supply. Canada's proposed P2 pollution prevention planning notice is modeled as a negative shock to the availability of imports. Canadian import demand elasticities are taken from a recent study by *Ghodsi, Grubler, and Stehrer (2022)*.[28] Retrieving domestic supply elasticities in Canada for individual fresh fruit and vegetable products is challenging, particularly for products where production is small or acres and/or greenhouse capacity is unknown. Thus, we assume domestic supply is inelastic (i.e., less responsive) in the short run and proxied by the share of domestic production in total availability within Canada. This means that the supply elasticity is increasing in the share of domestic production in total availability (from imports and domestic supplies), thereby allowing some supply response when domestic production makes up a larger component of total availability.

Model Results of ECCC's P2 Notice to Phase Out SUP Packaging

We now discuss the impacts of ECCC's P2 Notice to phase out plastic packaging on Canada's retail market prices and per capita availability of fresh fruits and vegetables.

Three import supply shocks are conducted to illustrate a range of impacts on Canadian consumers:

1) ***Low-Impact:*** *ECCC's plastic packaging restrictions lead to a 25% reduction of imports into Canada.*
2) ***Moderate-Impact:*** *ECCC's plastic packaging restrictions lead to a 50% reduction of imports into Canada.*
3) ***Higher-Impact (VCMI Study):*** *ECCC's plastic packaging restrictions lead to a 62% reduction of imports into Canada. Sixty-two percent represents the median of VCMI's 2019 and 2023 study, which estimated that 60% and 64% of fresh produce is sold in plastic packaging.*

In the interest of brevity, we keep the results focused on the importance of imports of fresh fruits and vegetables into Canada. Because alternative technology to plastic packaging that maintains the same level of quality does not yet readily exist, our results are best viewed as lower-bound estimates.[29] Naturally, for some products the price and per capita availability impacts could be even higher if we shocked imports and domestic supply simultaneously. At the same time, however, some fresh fruit and vegetable distributors could maintain (or even increase) the volume of product they choose to sell in bulk. Thus, we do not consider a scenario in which all imports plus domestic supplies are completely shut off. Moreover, we shock import supply regardless of where these imports originate. This is because if U.S. fresh fruits and vegetables are restricted from accessing the Canadian market because of the ECCC's pollution prevention planning notice, it is unlikely other key exporting countries such as Mexico or countries

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in Latin America could step in to fill the void. Thus, by varying the size of the import shock we present a range of retail price and per capita availability changes to help policymakers evaluate the potential economic toll on Canadian consumers. That said, given the substantial disparities across products in their possibility to be marketed in bulk (or otherwise free from any packaging), it is worth noting that the resulting figures might be overestimated for some products (e.g., apples or pears).

Table 2 presents our benchmark estimates for 14 fresh fruits and the same number of fresh vegetables based on a moderate-impact scenario in which 50% of import quantities can no longer reach the Canadian consumer. In **Table 2**, products are ranked in decreasing order of magnitude of the expected price impact (i.e., Expected Price Change). In the below discussion, we present retail prices in U.S. dollars per kilogram ($/kg) and include the equivalent Canadian dollar price per kilogram (CAD$/kg) in parentheses. According to the Bank of Canada, one U.S. dollar yielded CAD$1.30 in 2022.[30]

For the fresh fruit sector, (upper panel, **Table 2**), the highest impacted product in terms of expected price increases are tree nuts. Here, a 50% reduction in the supply of imported tree nuts results in a more than doubling of Canadian retail prices (123% increase). In 2021/2022, tree nuts retailed for $12.03/kg (CAD$15.64/kg) in Canada. If the ECCC's P2 regulation results in a 50% reduction of import supply, Canadian consumers could be expected to pay over $26 (CAD$33.80) for the same kilogram of tree nuts. The main reason for this and other large price changes in the fresh fruit category is the large share of imports in Canadian domestic consumption combined with a relatively low (i.e., inelastic) import demand elasticity and a domestic supply response that is virtually zero. Hence, a much larger increase in retail price would be needed to ration the ECCC's policy-induced supply shortage. Indeed, the new per capita availability of tree nuts is expected to decrease from 1.93 kg/person before the ban to 0.97 kg/person as shown in the last two columns of **Table 2**.

Likewise, for raspberries and citrus fruit products (lemons and limes, oranges, and grapefruit) retail prices are projected to increase more than 1.5 times (52.64% to 63.5%) their current price levels in Canada. For example, fresh oranges recorded one of the largest (absolute) declines in per capita availability from 8.74 kg/person to 4.37 kg/person. Moreover, oranges were the second largest fresh fruit product in terms of per capita availability in 2021/2022 behind apples. Oranges and other citrus fruits provide important nutrient benefits including vitamin C and fiber.

Conversely, the least impacted fresh fruits are those for which Canada is less dependent on imports to satisfy domestic demand, namely fresh apples, blueberries, and cherries. For example, the expected retail price increase for fresh blueberries is 6.6%, increasing from $22.46/kg (CAD$29.20/kg) to $23.94/kg (CAD$31.12/kg). The increase in retail blueberry prices results in a more muted impact on per capita availability in Canada, decreasing from 6 kg/person to 5.3 kg/person.

The lower panel of **Table 2** illustrates the market impacts of the ECCC's P2 regulation on fresh

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Table 2. Expected Change in Fresh Fruits, Tree Nuts, and Vegetable Retail Prices and Per Capita Availability in Canada

Sector/Product	Avg. Retail Price 2021/22	Change in Quantity Available	Import Demand Elasticity	Domestic Supply Elasticity	Expected Price Change	Expected Price Level	2022 Per Capita Availability in Canada	Expected Change in Per Capita Availability
Unit	*(USD/kg)*	*(%)*	----	----	*(%)*	*(USD/kg)*	*(kg/person)*	*(kg/person)*
Fresh Fruits & Tree Nuts								
Tree nuts	12.03	-49.97	-0.40	0.00	123.46	26.88	1.94	0.97
Lemons/Limes	5.59	-50.00	-0.79	0.00	63.50	9.15	2.08	1.04
Oranges	3.54	-50.00	-0.89	0.00	56.13	5.53	8.74	4.37
Raspberries	14.23	-50.00	-0.95	0.00	52.75	21.73	0.34	0.17
Grapefruits	3.29	-50.00	-0.95	0.00	52.64	5.02	0.86	0.43
Mandarins	3.80	-50.00	-1.00	0.00	49.98	5.70	3.97	1.99
Pears	4.20	-44.00	-0.97	0.12	40.26	5.89	1.75	0.98
Watermelons	4.92	-43.59	-0.97	0.13	39.65	6.87	6.99	3.94
Strawberries	8.98	-40.92	-0.96	0.18	35.76	12.19	3.41	2.01
Grapes	6.83	-32.98	-0.95	0.34	25.47	8.57	7.22	4.84
Cherries	14.42	-27.64	-0.96	0.45	19.68	17.26	1.18	0.85
Sour cherries	4.98	-17.34	-0.90	0.65	11.16	5.54	0.27	0.23
Apples	4.21	-18.41	-1.01	0.65	11.11	4.68	14.70	11.99
Blueberries	22.46	-12.07	-1.07	0.76	6.60	23.94	6.02	5.29
Fresh Vegetables								
Potatoes, sweet	2.93	-42.65	-0.98	0.15	38.00	4.04	2.47	1.42
Spinach	16.04	-42.31	-0.98	0.15	37.45	22.04	1.09	0.63
Cauliflower	6.10	-37.86	-0.93	0.24	32.39	8.08	3.15	1.96
Broccoli	7.24	-36.12	-0.93	0.28	30.01	9.41	3.31	2.11
Lettuce	8.46	-36.51	-0.96	0.27	29.72	10.97	9.37	5.95
Celery	1.04	-36.12	-0.99	0.28	28.45	1.34	2.93	1.87
Peppers	6.51	-20.08	-0.92	0.60	13.25	7.37	9.54	7.63
Cabbage	2.17	-20.00	-0.93	0.60	13.04	2.45	7.27	5.82
Onions and shallots	4.02	-23.15	-1.85	0.55	9.64	4.41	13.14	10.10
Potatoes	3.52	-6.73	-0.17	0.60	8.73	3.83	164.61	153.54
Carrots	2.11	-11.65	-0.80	0.79	7.32	2.26	11.49	10.15
Tomatoes	4.33	-9.89	-0.91	0.80	5.78	4.58	25.87	23.31
Cucumbers	6.95	-6.25	-0.98	0.88	3.36	7.18	9.18	8.61
Mushrooms	9.05	-3.29	-0.89	0.93	1.81	9.21	3.74	3.62

Source: Author's calculations from equilibrium displacement model.

**Note: The scenario results presented assume that 50% of Canadian imports of fresh fruits and vegetables are unable to meet the proposed plastic packaging restrictions in Canada in the short run. The supply elasticity is approximated for each product based on the current self-sufficiency rates in Canada.*

vegetables. Recall from **Figure 2** that nearly 40% of fresh vegetable availability in Canada is produced domestically, compared to just 24% for fresh fruits. Thus, Canada is more self-sufficient in the production of fresh vegetables to feed and nourish its population. Therefore, the percentage changes in retail prices of fresh vegetables are generally less than those for fresh fruits.

The highest impacted products are again those for which Canada is more import dependent. This includes sweet potatoes, spinach, cauliflower, broccoli, lettuce, and celery where retail prices are expected to surge more than 25% under the ECCC's proposal to phase out plastic packaging. For example, the average retail price of one kilogram of fresh cauliflower and lettuce in Canada in 2021/2022 was $6.10/kg (CAD$7.93/kg) and $8.46/kg (CAD$11.00/kg), respectively. Imposing a 50% reduction to import supply results in these prices increasing to $8.08/kg (CAD$10.50/kg) and $10.97/kg (CAD$14.26/kg), respectively. Per capita availability declines from 3.15kg/person to 1.96kg/person for cauliflower, and from 9.37kg/person to 5.95kg/person for lettuce. Conversely, with an expected price increase of less than 6%, the average Canadian shopper will be less impacted when purchasing fresh tomatoes, cucumbers, and mushrooms.

Conclusions and Implications

Environment and Climate Change Canada's proposal to require fresh fruits and vegetables be sold in bulk and/or plastic-free packaging without a readily available alternative is likely to be challenging for U.S. fresh produce industries to implement and costly for Canadian consumers. According to the evidence reviewed in this report, the ECCC's notice to phase out plastic packaging will increase the price of most fresh produce at a time when Canadian households are struggling with food price inflation rates that have exceeded 5% in every month since November 2021. Such regulations will also generate more food loss and waste, greenhouse gas emissions, and food safety risks, and reduce the accessibility of this nutritionally valuable food group among consumers.

Implications for the U.S. Fresh Produce Industry

Canada is the number one export market for U.S. fresh fruits and vegetables with export sales of over $4.6 billion in 2022. Forty-two percent of fresh fruits and 81% of U.S. fresh vegetable exports were sent to Canada in 2022, including 86% of U.S. fresh lettuce and 94% of fresh tomato exports. A 62% reduction in these exports—the share of fresh produce that is estimated to be distributed in plastic packaging according to VCMI (2023)—could result in economic losses of up to $2.8 billion for the U.S. fresh produce industry. Furthermore, it would be costly and challenging for U.S. fresh produce exporters to find alternative markets. This is because for more than two decades U.S. distributors have enjoyed a highly integrated, regionally focused, North American supply chain that is one of the most dynamic food systems globally, feeding a wealthy population with safe and nutritious fresh fruits and vegetables throughout the year.

Implications for Canadian Households

Overall, we find that retail prices of fresh fruits and tree nuts are projected to increase by 42% on average, compared to 19% for fresh vegetables under a moderate-impact scenario that reduces the supply of imports into Canada by 50%. To put these results in a broader perspective, we can use average household expenditure data published by Statistics Canada in 2021 (the latest year for which data are available).[31] In 2021, the average Canadian household spent $1,030 on fruit, fruit preparations, and tree nuts and $967 U.S. dollars on fresh vegetables and preparations. This suggests that the ECCC's pollution prevention notice for plastic packaging represents an annual tax of $616/household/year (CAD$801/household/year) in Canada. Seventy percent, or $433 out of the $616/household/year, can be attributed to the impacts of the ECCC's regulation on fresh fruits and tree nuts, whereas 30%, or approximately $183 of the $616/household/year, is attributed to the impacts of the ECCC's regulation on fresh vegetables.

In the higher-impact scenario (a 62% reduction of import supply), the resulting economic burden on Canadian households increases to $765/household/year or nearly CAD$1,000/household/year. What's more, under this scenario some fresh fruits and vegetables may become unavailable for Canadians. Much will depend on the ability of packagers, distributors, and retailers to stock a larger share of fresh produce in bulk, and whether Canadian grocery shoppers are willing to pay higher prices for produce that may be sensitive to bruises, blemishes, and decay.

Endnotes

[1] *FAO. 2022. "Trade of Agricultural Commodities: 2000-2020". FAOSTAT Analytical Brief No. 44, Rome, Italy, available at: https://www.fao.org/documents/card/en/c/cb9928en*

[2] *From 1989 to 1993, Canada and the United States pursued agricultural trade liberalization through the Canada-U.S. Free Trade Agreement (CUSTA) which was then folded into NAFTA (Zahniser et al., 2015).*

[3] *For convenience, we will refer to CUSTA, NAFTA, and USMCA as USMCA/NAFTA.*

[4] *This notice followed Canada's June 20, 2022 regulation announcing final regulations banning single-use plastic manufactured items: checkout bags, cutlery (i.e., silverware), certain foodservice ware, ring carriers, stir sticks, and most plastic straws.*

[5] *Environment and Climate Change Canada. 2023. "Pollution prevention planning notice for primary food plastic packaging: Targets for reduction, reuse, redesign, and recycled content," Consultation document available at: https://www.canada.ca/content/dam/eccc/documents/pdf/p2/20230728-01-EN.pdf*

[6] *The proposed targets to reduce single-use plastic packaging entering Canadian retail markets is part of ECCC's zero plastic waste by 2030 strategy. See https://www.canada.ca/en/environment-climate-change/news/2020/10/canada-one-step-closer-to-zero-plastic-waste-by-2030.html*

[7] *See www.vcm-international.com (2023) and summary by: Fraser Institute. November 2023. "Ottawa's next phase of 'plastics' war will increase cost of fruits and vegetables," available at: https://www.fraserinstitute.org/article/ottawas-next-phase-of-plastics-war-will-increase-cost-of-fruits-and-vegetables#:~:text=According%20to%20a%20new%20study,losses%20valued%20at%20%243.4%20billion.*

[8] *Brandenburg, J.S. and E. Vandercook. 2023. "Literature Review and Stake Holder Interviews: Plastic Packaging Challenges as they Pertain to Food Safety, Food Quality and the Realities of the Fresh Produce Industry," available at: https://cpma.ca/docs/default-source/industry/sustainability/cpma-litreview-food-safety-qfreshlab-dec-2023.pdf*

[9] *Kasza, G., N. Veflen, J. Scholderer, L. Münter, L. Fekete E.Z. Csneki, A. Dorkó, D. Szakos and T. Izsó. 2022. "Conflicting Issues of Sustainable Consumption and Food Safety: Risky Consumer Behaviors in Reducing Food Waste and Plastic Packaging," Foods, 11(21), https://doi.org/10.3390/foods11213520*

[10] *White, A. and S. Lockyer. 2020. "Removing plastic packaging from fresh produce – what's the impact?" Nutrition Bulletin, 45(1): 35-50.*

[11] *See: https://www.usda.gov/media/blog/2022/01/24/food-waste-and-its-links-greenhouse-gases-and-climate-change#:~:text=EPA%20estimated%20that%20each%20year,42%20coal%2Dfired%20power%20plants.*

[12] *See https://abacusdata.ca/*

[13] *CPMA. 2023. "Perceptions of Eliminating Plastic Packaging from Fresh Produce," available at: https://cpma.ca/docs/default-source/industry/sustainability/cpma-plastic-study-final-report-11-3-23.pdf*

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[14] *See October 19, 2023 CTV news summary at: https://www.ctvnews.ca/climate-and-environment/fresh-fruit-and-vegetable-producers-warn-proposed-plastic-reductions-could-spike-grocery-prices-1.6608282#:~:text=%E2%80%9CWe%20hear%20it%20from%20Canadian,some%20of%20the%20proposed%20targets.*

[15] *Deloitte. December 2023. "Impact Analysis of Environment and Climate Change Canada's (ECCC) Pollution Prevention (P2) planning notice and PLU legislation on the Canadian Fresh Fruit and Vegetable Industry," available at: https://cpma.ca/docs/default-source/industry/sustainability/impact-analysis-eccc-p2-plu-regs-on-fv-deloitte-dec-2023.pdf*

[16] *Statistics Canada. Table 18-10-0004-03. Consumer Price Index, monthly, percentage change, not seasonally adjusted, Canada, provinces, Whitehorse and Yellowknife — Food: https://doi.org/10.25318/1810000401-eng*

[17] *Scarpaleggia, F. April 2022. "The Impacts of a Ban on Certain Single-Use Plastic Items on Industry, Human Health and the Environment in Canada," Report of the Standing Committee on Environment and Sustainable Development, available at: https://www.ourcommons.ca/Content/Committee/441/ENVI/Reports/RP11670470/envirp02/envirp02-e.pdf*

[18] *Zahniser, S., S. Angadjivand, T. Hertz, L. Kuberka, and A. Santos. 2015. "NAFTA at 20: North America's Free Trade Area and Its Impact on Agriculture," A Report from the Economic Research Service, No. WRS-15-01, February.*

[19] *We ignore stock changes. As most fresh produce cannot be stored for significant periods of time, this assumption should not affect the results presented.*

[20] *According to data from FAOSTAT, Canada is the third largest producer of fresh blueberries, behind the U.S. (#1) and Peru (#2). See https://www.fao.org/faostat/en/#data*

[21] *This includes splitting cauliflower and broccoli into separate products. Cauliflower and broccoli are combined when working with 6-digit product codes of the Harmonized System of trade classification (HS 070410). However, as Canada does report imports at the 10-digit level, we can estimate the amount of imports of cauliflower separate from broccoli.*

[22] *Trade Data Monitor can be accessed (with subscription) at https://tradedatamonitor.com/.*

[23] *FAS/GATS can be accessed at https://apps.fas.usda.gov/gats/default.aspx.*

[24] *We exclude dried products as well as fruit and vegetable juice.*

[25] *Available at: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210005301*

[26] *FAOSTAT data can be accessed at: https://www.fao.org/faostat/en/*

[27] *Statistics Canada. Table 18-10-0245-01, Monthly average retail prices for select products DOI: https://doi.datacite.org/dois/10.25318%2F1810024501-eng*

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[28] *Ghodsi, M., J. Grübler, and R. Stehrer. 2022. "Import Demand Elasticities Revisited," The Journal of International Trade & Economic Development, 31(1): 46-74.*

[29] *It is also worth noting that our results focus on first-order effects to price and per capita availability and do not address larger economy-wide questions such as the longer-term health impacts to Canadian consumers should fresh fruits and vegetables become unavailable or unaffordable.*

[30] *Bank of Canada, Annual Exchange Rates, 2019-2023. Available at: https://www.bankofcanada.ca/rates/exchange/annual-average-exchange-rates/*

[31] *Statistics Canada, Detailed Food Spending, Canada, Regions and Provinces (per household), available at: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1110012501*

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