FAST AND FRESH

A Recipe for Canada’s Food Supply Chains.
Preface

Canada’s food supply chains are at the base of many food issues. The nature of these chains has an impact on Canadian companies’ competitiveness, the kinds of foods that Canadians eat, the prices they pay, and even the environmental footprint of Canada’s food economy. In this report, we analyze the economic forces shaping Canada’s food supply chains.
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The findings and conclusions of this report are entirely those of The Conference Board of Canada, not of the Centre investors. Any errors and omissions in fact or interpretation remain the sole responsibility of The Conference Board of Canada.

ABOUT THE CENTRE FOR FOOD IN CANADA

The Centre for Food in Canada (CFIC) is a three-year initiative of research and dialogue to help address one of the mega-issues facing our country today—food. Food impacts Canadians in an extraordinary range of ways. It affects our lives, our health, our jobs, and our economy.

The twin purposes of the Centre for Food in Canada are:

- to raise public awareness of the nature and importance of the food sector to Canada’s economy and society;
- to create a shared vision for the future of food in Canada—articulated in the Canadian Food Strategy—that will meet our country’s need for a coordinated, long-term strategy for change.

The Centre is taking a holistic approach to food. It focuses on food in Canada through three interrelated but distinct lenses: safe and healthy food, food security, and food sustainability. These lenses ensure that the Centre focuses on the full range of important issues facing the food sector.
The work involves a combination of research and effective communications. The goal is to stimulate public understanding of the significance of the food sector and spur the demand for collaborative action. To achieve its goals, the Centre is working closely with leaders and partners from Canada's food sector, governments, educational institutions, and other organizations.

Launched in July 2010, CFIC actively engages private and public sector leaders from the food sector in developing a framework for a Canadian food strategy. Some 25 companies and organizations have invested in the project, providing invaluable financial, leadership, and expert support.

For more information about CFIC, please visit our website at www.conferenceboard.ca/cfic.

CFIC INVESTORS
The Conference Board of Canada is grateful to the Centre for Food in Canada investors for making this report possible, including:

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- Loblaw Companies Limited
- Maple Leaf Foods
- Nestlé Canada Inc.
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- IBM Canada

- KPMG LLP
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- PepsiCo Canada
- Saputo Inc.
- Weston Foods

**Participant Investors**
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- The Heart and Stroke Foundation

**Participants**
- University of Guelph
Executive Summary

Fast and Fresh: A Recipe for Canada’s Food Supply Chains

At a Glance

- Perishable food products face unique challenges related to supply chain logistics.
- Small technological changes, infrastructure investments, or business processes can have large impacts on what food products can viably be shipped.
- How these changes impact the viability of food products can be anticipated through logistics cost modelling.
- Understanding this approach is useful not only for businesses, but for policy-makers and even consumers.

Food is grown where people are not. Moreover, perishable food does not like to travel. In other words, food has all of the worst characteristics of something that needs to be shipped. That is the challenge that buyers and sellers of food face on a daily basis.

Fortunately, advances in temperature-controlled technologies, infrastructure, food packaging, making use of information, and supply chain performance measurement have all helped to overcome this challenge. Temperature-controlled technologies are important for the movement of perishable foods. Fresh fruit in particular is still alive after it is harvested. It continues to breathe and sweat as it is stored and in transit to its final destination. Maintaining the right temperature and humidity dramatically reduces the rate at which the food breathes, allowing the producer to ship the fruit across vast distances over long periods. As such, the link between “freshness” and “distance” is largely severed.

The 20th century witnessed a large number of technological improvements, such as the introduction of refrigerated intermodal containers, which have dramatically altered the price and availability of the food we eat on a regular basis. But these improvements—both technological and otherwise—are ongoing and will continue to impact our food choices as consumers and the competitiveness of our food products as producers.

SUPPLY CHAIN COST MEASUREMENT

Businesses make numerous trade-offs between various supply chain logistics costs when making decisions about sourcing, transportation, warehousing, etc. They do this either implicitly through experience or explicitly with a logistics cost model. For buyers and sellers of food products, the trade-offs and related decisions are even more numerous.

Understanding the explicit approach to logistics cost trade-offs is useful on a number of fronts. For businesses, it allows for the optimization (minimization) of supply chain logistics costs and helps to extend the reach of
their products (or extend the reach of their sourcing). In addition, it allows them to anticipate the potential impacts of changes in technologies, infrastructure improvements, or policies on their costs and the competitiveness of their products.

For policy-makers, understanding these trade-offs and how they affect business decision-making will also help them to evaluate their own policies. This includes policies that affect customs processes and packaging as well as those regarding investment in public infrastructure.

Parallel metrics can also help consumers understand the benefits that supply chain logistics have had on their food choices and the prices they pay for food. But they can also be used to help educate the consumer on the full life cycle (from production to consumption) impact of the foods we eat. For example, consumers who choose to narrowly focus on the distance their food has travelled in order to reduce greenhouse gas emissions may in fact be choosing a product with a larger emissions footprint on a life cycle basis. This is the result of the fact that significantly more energy is consumed during the production process, relative to the transportation process.

### Developing the Canadian Food Strategy

The principal goal of the Centre for Food in Canada (CFIC) is to engage stakeholders from business, government, academia, associations, and communities in creating a framework for a Canadian Food Strategy—one that will meet the country’s need for a coordinated long-term strategy.

The Strategy will take a comprehensive approach to food. It focuses on food in Canada through five interrelated but distinct elements: industry prosperity, healthy food, food safety, consumer security, and food sustainability.

These elements ensure that the Strategy will be focused on the full range of important issues facing the food sector. Our work combines careful research and communications to enhance knowledge of the food sector, and spur interest in collaborative action.

The completed Strategy will present a framework of workable solutions and actions, and will identify food sector businesses, governments, communities, and other groups to lead on implementing them.

The process for creating, disseminating, and implementing the Strategy involves research, analysis, and synthesis; consultation and a high level of collaboration; the development of a shared understanding and shared objectives among stakeholders; broad dissemination though many communication channels; and commitment of key players to take action.

#### THE ROLE OF RESEARCH

The 20 research projects that are being undertaken as part of CFIC, including this report, are essential to the development of the Canadian Food Strategy. The process to develop the Strategy starts with conducting research that develops empirical findings and potential solutions to the challenges and issues facing the food sector. These research findings are being used as the basis for dialogue and consultation with CFIC investors and other major food stakeholders, which will culminate in the completed Canadian Food Strategy.

CFIC research aims to:
1. understand the current reality of Canada’s food system, including its impact on health, environment, trade, and other major economic and social factors
2. define a future desired state for the food system
3. suggest workable solutions for moving Canada from its current reality to the desired state. The workable solutions take into consideration the realities of economic activity, market forces, environment, policies, laws and regulations, and the social conditions and health needs of Canadians.

#### KEY STEPS AND TIMELINES

1. Begin CFIC research studies—July 2010
2. Develop initial draft Canadian Food Strategy—April 2012
3. Begin dialogue and consultations—July 2012
4. Release the Canadian Food Strategy—March 2014

#### CANADIAN FOOD SUMMIT EVENTS—LAUNCHING THE CANADIAN FOOD STRATEGY

Three major events are being held. The 1st Canadian Food Summit 2012 (February 2012) brought together more than 600 of Canada’s food system leaders and practitioners from business, government, academia, and communities to discuss the latest research, share insights, and discuss how best to address Canada’s major food challenges and opportunities. The 2nd Canadian Food Summit (April 2013) convened a group of Canadian and international stakeholders to discuss the latest research and engage in a dialogue on the draft Canadian Food Strategy. The 3rd Canadian Food Summit (March 2014) will be held to launch the Canadian Food Strategy.
Evolving Trends in Food Supply Chain Logistics

Canada’s supply chain infrastructure and expertise is mature. But ongoing incremental changes can still have large impacts for food producers and retailers. For example, many intermodal containers that enter Canada are shipped back out of the country empty. Collaborative efforts between shippers and carriers that help to efficiently reposition empty containers within Canada in order to ship them back out full can help to reduce logistics costs. Government policies that help to relieve logistics bottlenecks, either through more efficient border processes or investments in infrastructure, can have disproportionate effects on the competitiveness of fresh foods in particular. In some cases, where transit time is reduced by just a few hours, a product can suddenly be exposed to new markets around the world.

We conclude that:
- Supply chain efficiency metrics need to be developed in order to evaluate ongoing changes in supply chain and transportation options. This can help develop opportunities and manage threats as they happen.
- Policy-makers can and should use parallel metrics to evaluate the effectiveness of public investments and public policies.
- Both domestic and foreign hinterland infrastructure improvements can have major impacts on the cost and viability of moving food products from one place to another, so shippers and policy-makers should be aware of and understand changes on the other end of their logistics chains as well.
- Businesses can educate consumers on the environmental impacts of food products using a supply chain approach in order to widen the current narrow focus on the transportation impacts.
Chapter 1

Introduction

Chapter Summary

- Food is grown where people are not; perishable food does not like to travel. This is the challenge that food supply chains face.
- Advances in temperature-controlled technologies, infrastructure improvements, food packaging, use of information, and supply chain performance measurement have all helped to overcome this challenge.
- This report explores the underlying economics of and recent developments in Canada’s food supply chains. It provides insights and considers implications for industry, policymakers, and consumers.

The 1955 film *East of Eden* is widely remembered for James Dean’s first starring role. Perhaps secondarily (albeit by a wide margin), it is remembered for its portrayal of some of the early challenges related to food transportation and logistics.

In the film, Dean’s character, Cal Trask, had the grand idea of shipping crisphead lettuce in railway box cars stuffed with ice from California to the eastern U.S. market, where the product would fetch a higher price. His theory was sound. The value of lettuce was significantly higher in the more populous eastern market where demand was high but supply was low. If he could transport the lettuce from the west to the east at a cost that was lower than the difference in value of the lettuce in the two markets, the residual value would be his (or more specifically, his father’s) to keep.

However, his execution was poor. A couple of days after the box cars departed, word got back to the Trasks that their entire shipment of lettuce, along with much of their personal fortune, was spoiled and lost en route (they should have started with a trial run of a single box car!).

Refrigerated railway cars, semi-trailers, and intermodal containers have completely changed the dynamics of temperature-controlled food transportation.

That was 1917. Eventually, shippers did manage to make the transportation of crisphead lettuce in ice-filled railcars more or less work, hence its now familiar name— iceberg lettuce. Since then, refrigerated railway cars, semi-trailers, and later, intermodal containers have completely changed the dynamics of temperature-controlled food transportation. Iceberg lettuce can now easily endure two to three weeks of transit time, as long as it

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is maintained at the right temperature (0°C) and relative humidity (90 to 98 per cent), as can its increasingly popular cousin, romaine lettuce.2

But this has not minimized the importance of transportation and logistics costs on the lettuce supply chain. In fact, increased shipping costs, due in part to rising fuel surcharges, have prompted greater production of romaine in the eastern U.S., along with salad plants for handling the processing in places like Ohio and North Carolina.3

Food is generally grown where people are not. And perishable food does not like to travel. In other words, food products have the worst characteristics of something that needs to be shipped. That summarizes the challenges that face food supply chains. Advances in temperature-controlled food transportation technology are just one contributor to food supply chain logistics improvements over time. Infrastructure, food packaging, making use of information, and supply chain performance measurement are other examples of areas where advances have improved our food supply chain logistics.

2 Hamberg Süd, Stay Cool We Care, 33.
3 University of Kentucky, Romaine Lettuce, 1.
ABOUT THIS REPORT

This report explores the underlying economics of Canada’s food supply chains. As we explain in the report, Canada has multiple food supply chains because the nature of food varies considerably based on characteristics like perishability. We analyze recent developments in food supply chains and work through the implications for industry and consumers.

Our method began with a review of the relevant literature. We analyzed international food-related trade data and interviewed industry stakeholders. We used this information to conceptualize how shippers (anyone who is a commercial buyer or seller of food products, including primary producers, food processors, or retailers) measure their supply chain logistics performance and how this measurement differs by food products. We then considered the implications for where and how certain food products are shipped, how this may change in the future, and what it means for Canadian food producers, processors, and retailers. We also considered the benefits that these advances have had for the ultimate beneficiary of supply chain improvements—the Canadian consumer.
Chapter 2

Understanding the Economics of Food Supply Chains

Chapter Summary

- Buyers and sellers of food products make trade-offs with respect to transportation, sourcing, packaging, warehousing, and other factors when organizing their supply chains.
- These trade-offs are made either implicitly through experience or explicitly through logistics cost modelling.
- This chapter describes these trade-offs and how the characteristics of different food products affect the decision-making process.

Improvements in transportation and logistics have allowed for more efficient supply chains and resulted in a variety of benefits for buyers and sellers of food products. These benefits flow through to consumers and manifest themselves in a number of different ways, such as lower food prices, greater year-round availability, and wider selections of food products.

Economics is about making choices when faced with constraints. Consumers face a food budget constraint within which they make choices about the prices, variety, and freshness of their food basket. These choices spill over to the businesses that manage the logistics of Canada’s food supply chains—“from farm to fork.”

Companies have a variety of technical options to address consumer demands. But how do they balance the costs associated with more sophisticated supply chain practices with the benefits they bring? And how do they know when and where to take advantage of these practices in order to make decisions about sourcing (where to buy inputs), modal choice, location decisions, and destination markets (where to sell food products)?

MAKING TRADE-OFFS

It is difficult for most consumers to conceptualize supply chain choices because while everyone eats food, only a handful of Canadians actually design food supply chains. For expositional purposes, perhaps it helps to begin our discussion with the logistical decisions that people make as they plan their daily travel. This demonstrates how people deal with constraints in their own logistical arrangements. We can then apply the same principles to food supply chains.

People travel in a number of different ways and at a wide range of speeds. For their commute to work, some drive their own vehicle, others walk or cycle (active travel), while some opt for urban transit—itself opening up the possibility of several distinct modes (bus, rail, etc.). The mode and speed of individual travel depend on a variety of decisions. Most of the decisions involve a trade-off between cost and convenience. (See box “Transit Time Variability—Commuter Analogy.”)
Some who choose urban transit or active travel save on out-of-pocket costs but spend more time travelling. Others will make the decision to choose a short commute for a smaller living area (opting for a downtown condo over a large home in the suburbs). A look at the spatial characteristics of any Canadian municipal area shows how Canadians make these choices.

The movement of freight is subject to similar trade-offs. Except, in the case of freight, the owner (buyer or seller) makes the decisions based on alternative costs. The most obvious trade-off is between the choice of mode of transport (faster and more expensive or slower and less expensive) and inventory costs (smaller inventory and lower cost or larger inventory and higher cost). The optimal choice minimizes the sum of the two costs. Shippers will often attempt to minimize the sum of the two either implicitly as a result of their past business experience or explicitly with a total logistics cost model.

Transit Time Variability—Commuter Analogy

A commute to work in the morning may be 30 minutes. However, it is unlikely to always be 30 minutes each and every day. Traffic conditions may make the commute slightly shorter on some days and longer on other days.

As a result, whether they do so explicitly or not, commuters build a buffer time into their commutes. Commuters with a 30-minute average commute may elect to build in 10 additional minutes of buffer time for a total planning time of 40 minutes, due to the trip time variability. If they were to do this explicitly, they could base the planning time on the length of the commute that will allow them to arrive at work on time 95 per cent of the time. This is analogous to a shipper setting its customer service level (in-stock) at 95 per cent.

For commuters, the implication is that they are indifferent to a commute with a planning time of 40 minutes and another commute with a constant trip time of 40 minutes. For shippers, they may be indifferent to a faster but less-reliable mode of freight that costs the same as a slower but more-reliable mode that allows them to achieve the same customer service level.

Source: The Conference Board of Canada.

Exhibit 1
Components of Supply Chain Logistics Costs

THE ECONOMICS OF LOGISTICS:
TOTAL LOGISTICS COST

In this section, we demonstrate how the characteristics of the goods being produced and shipped can influence supply chain decisions such as modal choice. We start with the general case and then move on to a food product-specific case. Exhibit 1 illustrates the core components of the supply chain logistics costs that we consider. (See box “The Model—Total Logistics Cost” for an explanation of the model.)

We can illustrate the functioning of a total logistics cost model that explicitly considers these core components through a concrete example. In our example, the shipper has a choice to transport a product by truck or rail. Table 1 shows the parameters with which the shipper is faced.

PRODUCT VALUE

The product value is the cost of the product at the beginning of its journey (regardless of when ownership of the product changes hands, as explained in the following discussion on the cost of capital rate). In the model, it is represented by the unit price of the goods (v), which is in turn used to calculate carrying costs due to the EOQ (1), the time spent in transit (3), and safety stocks due to lower levels of service (5).

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1 Total logistics cost is a subset of total landed cost. Generally, total landed cost is a broader term that includes the value of the product that is being shipped in the cost. Total logistics cost refers only to the transportation and logistics costs (effectively the total landed cost minus the initial value of the product).

2 Economic (minimum) order quantity.
The Model—Total Logistics Cost

The total logistics cost concept was initially defined by Baumol and Vinod in 1970 for the purpose of explaining the choice of transport mode made by shippers. The model was subsequently updated by other researchers such as Tyworth, who added sourcing decisions to the mix.

Baumol originally defined the model as follows, which largely remains as the basis for total landed (logistics) cost models today:

\[ TAC = \frac{Q \cdot v \cdot w}{2} + A \cdot \frac{D}{Q} + t \cdot \frac{365}{365} (D \cdot v \cdot w) + T \cdot D + S \cdot v \cdot w \]

where:
- \( TAC \) = total annual cost
- \( Q \) = order quantity
- \( D \) = annual demand
- \( v \) = unit price of the goods
- \( w \) = holding cost expressed as a percentage
- \( A \) = unit cost of an order
- \( t \) = time in days for transport
- \( T \) = per unit transportation cost
- \( S \) = safety stock

and,
- 1 = inventory carrying cost due to the economic (minimum) order quantity (EOQ)
- 2 = order processing costs
- 3 = in-transit carrying costs, including the cost of capital and depreciation while in transit
- 4 = direct transportation costs
- 5 = standing inventory costs as a result of lower level of transportation service

We employ a modified version of this model in order to illustrate the trade-offs among inventory levels, transportation costs, and transportation service levels when making supply chain decisions.

Table 1
Product Attributes (Example)

<table>
<thead>
<tr>
<th>Product value (per tonne)</th>
<th>$100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of capital rate</td>
<td>10%</td>
</tr>
<tr>
<td>Rate of obsolescence (depreciation)</td>
<td>10%</td>
</tr>
<tr>
<td>Customer service level (in-stock)</td>
<td>95%</td>
</tr>
</tbody>
</table>

Source: The Conference Board of Canada.

COST OF CAPITAL RATE

The cost of capital reflects the shipper’s (buyer and/or seller) financing cost. While a product is in transit or in storage, it is not producing any value for the owner. However, the purchase of the product must be financed by debt, equity, retained earnings, or some combination of the three. In the basic total logistics cost model, the cost of capital rate is reflected in the holding cost expressed as a percentage (w), which in turn impacts the carrying costs due to the EOQ (1), the time spent in transit (3), and the time spent in storage (5).

For international shipments, ownership of the good changes hands at a time specified by the agreed upon Incoterm. For example, a common Incoterm is Free on Board (FOB). For goods shipped FOB, the ownership of the goods changes hands from the seller to the buyer at the port of origin. On the other hand, when goods are shipped as Cost, Insurance, and Freight (CIF), ownership of the goods changes hands at the port of destination.

At first glance, it might appear that for the purpose of evaluating total landed costs we would have to first identify the Incoterm. However, regardless of when ownership changes hands, the inventory is costing someone. Furthermore, under Incoterms where the seller holds on to the ownership for a longer period, that cost will ultimately be reflected in the transaction.

3 Technically, the cost of capital may vary by division or product line within a company in relation to the level of systematic risk associated with that division or product.

4 Incoterms, or international commercial terms, are a set of international rules that lay out agreed upon definitions and interpretations of commonly used trade terms.
price. And to further complicate things, the buyer starts to absorb financing costs only when payment is actually made, which could be before or after the change in legal ownership. So while buyers and sellers would do well to understand when ownership changes and the implications of who bears what cost, the timing of that change does not actually affect the total landed cost of the shipment from the start to the end of its journey.

RATE OF OBSOLESCENCE
The rate of obsolescence refers to the speed with which the product depreciates. Depreciation can occur for a number of reasons, such as physical wear, technological obsolescence, or in the case of food, spoilage. The rate is also reflected in the holding cost expressed as a percentage (w).

CUSTOMER SERVICE LEVEL
The customer service level refers to the frequency with which the product is in stock when a customer is looking for it, with the variability of demand being held constant (since we want to isolate the impact of transit time variability on the in-stock frequency). Transport modes with no transit time variability will allow the shipper to meet the desired customer service level with no additional delivery lead time and/or safety stock. Conversely, unreliable transportation modes will require the shipper to hold safety stock and/or increase order lead times, both of which add costs.

Alternatively, shippers may elect not to set a fixed customer service level but instead let the level vary according to the cost of a “stock out.” A stock out occurs when a customer demands a product that is not in stock. The shipper can cost this stock out as a loss in an individual sale, a loss in a repeat customer (i.e., many future sales as well), or a delay in a sale, etc. This cost is then traded off with the level of service that each mode of transportation can provide in order to minimize total landed costs.

THE IMPACT OF SHIPMENT SIZE
Transportation alternatives are associated with different optimal shipment sizes, which are generally correlated with the capacity of the transport vehicle. Thus, rail transport cost is lower than truckload (TL) transport cost. However, the minimum shipment size for LTL shipment is smaller than the minimum size shipment required by TL, and so on. This has an impact on inventory costs. If a shipper chooses to minimize transportation cost by choosing rail (in this example), it may have to order a quantity that cannot be sold in a short period, resulting in inventory being held until the product is sold and the stock depleted.

Table 2 shows the variables that influence the costs by mode. The general difference is that shipping by truck is generally faster and more reliable than shipping by rail, but comes at a premium freight rate (direct transportation cost).

From the product attributes (Table 1) and assumptions about truck and rail service levels (Table 2), we can calculate how the total logistics cost varies according to the choice of transportation mode. Table 3 summarizes these results.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Truck</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of capital (%)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Rate of obsolescence (%)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Total holding cost (%)</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Annual demand (D), tonnes</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Unit cost of the order (A), $</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Unit price of the good (v), $</td>
<td>10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Per unit transportation cost</td>
<td>150</td>
<td>75</td>
</tr>
<tr>
<td>Customer service level (%)</td>
<td>0.95</td>
<td>0.95</td>
</tr>
<tr>
<td>Transit time (days)</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Transit time variability (days)</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Minimum shipment size to obtain rate in tonnes</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

Source: The Conference Board of Canada.
In this example, the cost of shipping by truck exceeds the cost of shipping by rail. This comes as a result of the premium freight rate. The freight rate is offset to some extent by the lower in-transit and standing inventory costs, as the truck shipments spend less time in transit and the more reliable service necessitates lower levels of safety stock. However, the savings are not enough to offset the freight rate premium.

**HOW FOOD SUPPLY CHAINS DIFFER**

Similar trade-offs between direct cost and service levels apply throughout the food supply chain. For perishable foods, the trade-off is more evident, whereas for unprocessed farm products the trade-off is less evident. And while the above example considered the trade-off as a function of a choice between transportation modes, trade-offs are also made when considering different sourcing locations (where to buy inputs), routing options, service levels (expedited vs. regular service), destination markets (where to sell your products), and packaging (such as vacuum packing to increase shelf life).

The characteristics of food products and their implications for supply chain costs vary by the type of product. Table 4 provides a general overview of how common food product attributes impact supply chain costs.

**Table 3**

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Truck</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct transportation cost</td>
<td>18,000</td>
<td>9,000</td>
</tr>
<tr>
<td>Inventory carrying cost due to minimum shipment size</td>
<td>18,000</td>
<td>18,000</td>
</tr>
<tr>
<td>Order processing cost</td>
<td>1,200</td>
<td>600</td>
</tr>
<tr>
<td>In-transit carrying cost</td>
<td>3,945</td>
<td>7,890</td>
</tr>
<tr>
<td>Standing inventory cost (safety stock)</td>
<td>658</td>
<td>2,630</td>
</tr>
<tr>
<td><strong>Total logistics cost</strong></td>
<td><strong>41,803</strong></td>
<td><strong>38,121</strong></td>
</tr>
</tbody>
</table>

Source: The Conference Board of Canada.

**DRY VS. TEMPERATURE-CONTROLLED FOODS**

Dry freight (“regular stuff” that doesn’t need to be temperature controlled) will often be consolidated into truckloads to maximize transportation productivity. For example, for grocery retailers that must replenish store stock on a regular basis from a distribution centre, various goods such as canned goods, cereals, condiments, baking goods, and snacks can be shipped in a single trailer.

There are major benefits that result from this practice. A store does not need a full truckload of any one of the dry goods, so consolidating many different products allows more frequent deliveries in large-size vehicles. The mixing of products of different density also results in less empty space being transported, since a combination of high- and low-density products will use the weight and storage capacity of a trailer or container more efficiently. For example, a trailer load of soup will reach its weight capacity before it reaches its volume capacity while cereal will lead to the opposite problem. By mixing both soup and cereal (with the soup on the bottom of course), both the weight and volume capacity of the trailer is used, resulting in less trips for the same amount of product moved. This increases productivity and lowers prices for shipping goods. In addition, the quantity level at which shipping the goods becomes economical decreases. This allows for goods to be delivered in smaller batches and on a timely basis, which in turn reduces inventory costs. This increases the availability of the product for consumers and ultimately lowers prices.

Perishable food products present additional challenges because of the range of temperature sensitivities of various food products. For this reason, multiple temperature zone “reefer” (refrigerated) trailers have gained in popularity. These units generally offer up to three independent temperature zones in a wide range of configurations. They are particularly popular for retail applications, where temperature-controlled services are required to replenish store stock with relatively small quantities from regional distribution centres.
## Table 4
Characteristics Distinguishing Supply Chain Costs of Food Products vs. General Freight

<table>
<thead>
<tr>
<th>Variable</th>
<th>General freight</th>
<th>Food products</th>
<th>Implications for food supply chain costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (lbs./cu. ft or kg/m³)</td>
<td>Ranges from less than 1 lb./cu. ft. to over 15 lbs./cu. ft. (NMFTA classifications)</td>
<td>Large range as well, but generally on the lower end (less dense) since many food products are packaged for direct consumption and not sold in bulk; exceptions are generally canned products.</td>
<td>High-density cargo makes air transport an option in some cases. It can have implications for truck freight rate. Truck average is about 10 lbs./cu. ft.</td>
</tr>
<tr>
<td>Value density ($/weight)</td>
<td>Ranges considerably. Truck freight averages about $2.50 per kg, rail freight about $1 per kg.</td>
<td>On the lower end. Grains are generally valued at 10 to 50 cents per kg. Fruit is often in the $1 to $2 range. Processed foods will be higher.</td>
<td>Food with low-value density or unprocessed food will be more conducive to rail shipments. Slightly higher-valued grains may move in containers (e.g., pulses).</td>
</tr>
<tr>
<td>Perishability/shelf life</td>
<td>Generally not an issue.</td>
<td>Most foods have a limited shelf life, but this can be extended through cold chaining (i.e., providing a temperature-controlled supply chain). Frozen products can be stored for months. Chilled (fresh) products have a shorter life. In either case, value declines during transit.</td>
<td>Supply chain costs for many food products are increased due to loss of shelf life while in storage/transit. This increases the need for timely transit and lower inventories. Reefer containers are much more costly to own and operate than standard containers, further adding to the cost.</td>
</tr>
<tr>
<td>Economic depreciation</td>
<td>Particularly an issue for certain electronics, textiles, and other consumer items due to rapid changes in technology and consumer preferences. Adds cost for longer transit times/storage as a result.</td>
<td>Not an issue. While many foods lose value due to loss in shelf life while in transit, the demand for a given product generally is unlikely to wane during transit time. Value may even increase during transit.</td>
<td>If perishability is not an issue, the transit time will not matter a great deal. Grains and other crops are an example, where transit times of months is tolerable.</td>
</tr>
<tr>
<td>Order quantity</td>
<td>Varies. Larger-order quantities will generally mean better freight rates (but potentially higher inventory costs).</td>
<td>Grains are shipped in large volumes. Some niche fresh products need to be shipped in small volumes.</td>
<td>When the volume is less than truckload (LTL) for fresh products, this is a problem because LTL services for fresh products in Canada are limited. As a result, shippers will have to pay the truckload price or ship by air.</td>
</tr>
<tr>
<td>Supply variability</td>
<td>Will vary, but typically suppliers have control over their production, so supply variability is not always an issue.</td>
<td>Many food products are seasonal. Large agri-firms have made acquisitions in several parts of the world in order to secure year-round supply. Weather variability can also add uncertainty.</td>
<td>Higher storage costs (due to larger inventory) as a result, where it is possible. Price will vary by season in some cases, though this can be offset by supplying from different regions at different times of the year.</td>
</tr>
<tr>
<td>Demand variability</td>
<td>Products with more variable demand require more inventory or a faster mode of transportation.</td>
<td>Demand variability is not as high as it may be for many consumer products. In fact, the closer a food product is to being a commodity, the more stable its demand variability.</td>
<td>Unlikely to add significant cost relative to most freight.</td>
</tr>
</tbody>
</table>

NMFTA = National Motor Freight Traffic Association  
Source: The Conference Board of Canada.
Until recently, intermodal containers were typically single-temperature units. Dual-temperature units have become available over the past few years, opening up possibilities of smaller shipments worldwide. These containers include a movable bulkhead partition that allows shippers to customize the size of each temperature zone according to their needs. For example, a shipper can elect to split a 40-foot container into two 20-foot zones, one for frozen food and the other for fresh food. Or, the shipper can create a 14-foot fresh zone along with a 26-foot frozen zone.5

Before the introduction of dual-temperature containers, a shipper would have to pay for more than 40 feet of cargo space for less than 40 feet of cargo if the cargo included a mix of temperature sensitivity. Or, the shipper would have to wait until there was a full container load of each product to ship, something that is not always possible, for fresh products in particular.

Significant additional costs are associated with transporting perishable goods relative to non-perishables (the capital cost of the reefer container and the fact that the goods are more delicate and more easily damaged). But advances in these and other technologies (such as vacuumed packaging) mean that producers and consumers of perishable goods are realizing the same benefits that consolidation has provided for dry freight. These new technological advances have stimulated the disproportionate growth of international perishable food shipping in recent years,7 relative to the growth in shipping for non-perishable goods.

These and other factors have implications for food supply chain costs, particularly when considering fresh food products. Here we consider another modal choice example using a total logistics cost approach using fresh food product attributes. The annual demand and modal variables remain similar to what they were in Table 2, with the key departure being the rate of obsolescence. Rather than assuming an asset life of several years as in the general case, we assume an asset life of just 20 days. In addition to these changes, we could consider the myriad of options that are now available due to the improvements described above, such as higher or lower freight rates and larger or smaller shipment sizes, depending on the specific type of container chosen for the job.

An additional day or two in a temperature-controlled environment does not correspond to a day or two less that the product can be left on the shelf in the store, as freshness is maintained while the temperature is controlled.

Also, rather than making use of a straight-line method of depreciation, we use a hyperbolic rate of depreciation.8 A case can be made for a variety of depreciation methods (including geometric) depending on the nature of the product and the implications for late delivery. In this case, we chose hyperbolic depreciation partly because the shelf life changes dramatically depending on the environment. (See box “Storage Life vs. Shelf Life and the ‘Goldilocks’ Temperature.”) Spending an additional day or two in a temperature-controlled environment does not correspond to a day or two less that the product can be left on the shelf in the store, as freshness is maintained while the temperature is controlled. However, if enough time elapses during transit or storage (even if temperature is controlled), it begins to have serious implications for the eventual shelf life in the store, if the product even makes it there at all. For this reason, the product may not depreciate very quickly initially, but will start to depreciate rapidly toward the end of its shelf life—which is precisely the result of a hyperbolic rate of depreciation.

5 Carrier, Dual Temperature Guide.
6 Cargo space is often sold in linear feet. Many international containers are 40 feet in length. In this case, 40 feet of cargo represent the total capacity of the container.
7 For example, worldwide perishable reefer trade increased from 113 million tons in 2000 to 157 million tons in 2009, an increase of 39 per cent (Chen and Notteboom, “Distribution and Value-Added Logistics”). U.S. reefer exports were up 16 per cent in 2011 while imports were up 17 per cent (Sowinski, “Ports and the Gold Chain”).
8 The hyperbolic rate of depreciation takes the functional form:

\[ V_t = V_0(T - (t - 1)) ÷ (T - \beta(t - 1)) \]

where, \( t \) are the years 1,2,..., \( T \), and \( \beta \) is the slope coefficient. In this example, the slope coefficient has been set to 0.8. A higher coefficient results in more depreciation in later years (or days). See Organisation for Economic Co-operation and Development, Measuring Capital, 61.
Chart 1 demonstrates the combined effect of a hyperbolic rate of depreciation and short asset life.

In addition, the inventory and in-transit carrying costs resulting from the cost of capital and obsolescence are estimated separately. Table 5 provides the new input values and Table 6 shows the impact on total logistics cost.

Recall from Table 3 that the rail option was determined to be less costly. In this case, the truck option is less costly, and by a large margin. In addition, the logistics costs are significantly higher overall. The rail option becomes so prohibitively expensive that it is no longer a viable option at all. The combination of the longer transit time and higher transit time variability of the rail shipment results in the expected delivery of the product toward the end of its shelf life.

Table 5
Truck vs. Rail, Annual Demand Variables (Fresh Food Product)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Truck</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of capital (%)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Rate of obsolescence (method)</td>
<td>hyperbolic</td>
<td>hyperbolic</td>
</tr>
<tr>
<td>Annual demand (D) (tonnes)</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Unit cost of the order (A) ($)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Unit price of the good (v) ($)</td>
<td>10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Per unit transportation cost</td>
<td>150</td>
<td>75</td>
</tr>
<tr>
<td>Customer service level (%)</td>
<td>0.95</td>
<td>0.95</td>
</tr>
<tr>
<td>Transit time (days)</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Transit time variability (days)</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>EOQ (tonnes)</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

Source: The Conference Board of Canada.

Table 6
Total Logistics Cost, Truck vs. Rail (Fresh Food Product) ($)

<table>
<thead>
<tr>
<th></th>
<th>Truck</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct transportation cost</td>
<td>18,000</td>
<td>9,000</td>
</tr>
<tr>
<td>Inventory carrying cost due to EOQ</td>
<td>9,000</td>
<td>9,000</td>
</tr>
<tr>
<td>Order processing cost</td>
<td>1,200</td>
<td>600</td>
</tr>
<tr>
<td>In-transit carrying cost</td>
<td>1,973</td>
<td>3,945</td>
</tr>
<tr>
<td>Standing inventory cost (safety stock)</td>
<td>329</td>
<td>1,315</td>
</tr>
<tr>
<td>Direct obsolescence cost</td>
<td>61,314</td>
<td>342,857</td>
</tr>
<tr>
<td>Total logistics cost</td>
<td>91,815</td>
<td>366,717</td>
</tr>
</tbody>
</table>

Source: The Conference Board of Canada.
This is a direct result of the perishability of the product. In fact, the obsolescence cost (which is isolated in this result) is by far the most significant cost of all the variables—a result that is not uncommon for perishable products. This demonstrates both the importance of accurately measuring the rate and nature (functional form) of obsolescence, as well as its corresponding impact on logistics costs. This is not only important in terms of modal choice, it also signals buyers and sellers where to sell to or source from, and how that might change due to improvements in supply chain efficiencies. This demonstrates why the supply chain logistics for food products need to be tightly managed—small errors lead to substantial costs. Lastly, it provides a quantified explanation of why cold chain (a temperature-controlled supply chain) improvements over time have had such a dramatic impact on food product markets, and why incremental changes in the future can continue to have disproportionate impacts.

**SERVICE-LEVEL PECKING ORDER AMONG FOODS**

The market determines which food products get priority seating and which are relegated to economy class (the service-level pecking order). This is determined according to the value, bulkiness, and perishability of the product. Table 7 provides an overview of the service-level pecking order for certain food products and how they relate to inventory levels and transit times.

Food products can move up or down the pecking order over time as market conditions, technologies, and the cost of options change. For example, some grain products are being shipped by container due to:

- **The increase in the value of the product.** For example, the value of many grain products, such as canola and pulse crops, has increased significantly over the past decade.

- **Import/export container imbalances.** The volume of imports from Asia-Pacific countries has grown rapidly, particularly through West coast ports. This has created an opportunity for backhaul movements with lower freight rates in attempts to minimize empty container movements.
  - Domestic container positioning poses another problem. Most import movements are destined for the large consumer markets in Vancouver, Calgary, Toronto, and Montréal. However, exporters are located across the country where the consumer markets are not nearly as large. This creates an even greater imbalance (in the other direction)

---

**Table 7**

<table>
<thead>
<tr>
<th>Pecking order</th>
<th>Low</th>
<th>Medium</th>
<th>Medium to Low</th>
<th>Low Perishability</th>
<th>Medium to Low Perishability</th>
<th>Medium Perishability</th>
<th>Medium Value</th>
<th>High Value, High Perishability</th>
<th>High Value, High Perishability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example products</strong></td>
<td>Grains, grain products</td>
<td>Some grain products, non-perishable packaged food</td>
<td>Some fruits, frozen meat, some fresh meat</td>
<td>Some fresh meat (pork, poultry)</td>
<td>Fresh fish, high-value fruit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Product attributes</strong></td>
<td>Low value, low perishability</td>
<td>Medium to low value, low perishability</td>
<td>Medium perishability, medium value</td>
<td>Medium value, high perishability</td>
<td>High value, high perishability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Transport mode</strong></td>
<td>Rail to port, bulk ocean carriers, rail hopper cars</td>
<td>Rail to port, intermodal containers, container ships</td>
<td>Rail to port, reefer ships, or intermodal reefer containers on container ships</td>
<td>Truck to port, reefer trailer transload, or intermodal container</td>
<td>Truck to air, reefer trailer to air transport container</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Inventory levels</strong></td>
<td>Very high</td>
<td>High</td>
<td>Medium</td>
<td>Medium/low</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Transit time</strong></td>
<td>Very slow</td>
<td>Slow</td>
<td>Slow/medium</td>
<td>Medium</td>
<td>Fast</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: The Conference Board of Canada.
that causes difficulty and higher logistics costs for exporters in those regions. For example, in the Manitoba market, for every loaded import reefer container there is demand for up to 400 export reefer containers (the province is a large exporter of pork products in particular). Exporters effectively have to pay for the cost of exporting the product plus the cost of repositioning empty reefer containers from other parts of the country.

This problem is particularly apparent in the Prairie provinces. Naturally, regions that produce a lot of grain, for example, are also more sparsely populated. These regions might ship more of their grain products by container if there was also large demand for those containers to come back to the same region.

- Growing importance of food inspection and food quality.

Growing importance of food inspection and food quality. When grains are shipped via bulk vessels, they are subject to greater handling and therefore greater potential for contamination. When shipped in containers, they can be handed off from one mode of transport to another seamlessly.

Food products will not always move “from left to right” in the pecking order. For example, many tropical fruits such as melons and pineapples that had been carried by air have been switched to ocean shipping because of cold supply chain improvements. In effect, these improvements have made the seaborne option “good enough,” making the more expensive air freight option less worthwhile. The lesson for shippers of food products currently using expedited options is always to be aware of the changing price and service levels of lower-priced alternatives in the event that the service quality to price ratio has improved enough to warrant a shift.

**FRESH FOOD BY RAIL**

Frozen food products have a much longer shelf life and are less sensitive to temperature fluctuations than fresh or chilled food products. In the event of an equipment failure, frozen products can typically last a day or longer before thawing, allowing time for alternative arrangements to be made. This also makes the hand-off from one mode to another easier to manage. As a result, it is not uncommon for large volumes of frozen food (such as frozen pork) to be shipped by rail to port for loading on a containership.

There is a strong preference for trucking to port due to the ease of tracking, level of service, and flexibility provided by trucking. For example, if there is a failure in the reefer (caused by human error or equipment failure), the driver can be notified immediately and alternative arrangements can be made in order to save the shipment from spoilage. It is much more difficult to stop a train and bring the container or refrigerated rail car to a dealer for servicing.

**Frozen food products have a much longer shelf life and are less sensitive to temperature fluctuations than fresh or chilled food products.**

However, shippers of food products should be aware of the growing potential for rail to enter the “good enough” category for certain fresh food products. For long-haul shipments, this typically means freight bill reductions of 15 to 18 per cent. This is the result of recent efforts by the Class I railways (CN Rail and CP Rail) to improve their fresh food services through the following investments:

- **Investments in tracking and tracing technologies.**

Real-time temperature monitoring is cheaper through GSM (global system for mobile communications) technologies than it is through satellite technologies. CN Rail is currently investing in information communications technology solutions that allow it to provide real-time temperature monitoring to the customer using the most economical monitoring systems. This would mean collaboration with all stakeholders, including shipping lines, as they typically are responsible for the freight during international movements.

9 Anonymous industry representative, phone interview by Vijay Gill, September 17, 2012.
• **Investments in clip-on generator sets for reefer containers.** Currently, most refrigerated containers carried by railways are connected to a genpack for power. These genpacks can power up to 16 reefer containers, but need to be connected to at least 10 in order to prevent overload and to be financially viable. On the other hand, clip-on gensets can power individual reefer containers. This allows railways to enter smaller, non-traditional markets and/or provide more frequent refrigerated service with smaller minimum order quantities—a must for many fresh food products.

**SYNOPSIS**

This chapter provided a framework for shippers to measure their supply chain logistics costs. This framework can be used to inform sourcing, modal choice, inventory, and destination market decisions. In addition, it can also help policy-makers and analysts anticipate the impact of pending changes in supply chain logistics input prices (such as freight rates and storage costs) and infrastructure improvements.
Chapter 3

Why Should We Care About Food Supply Chains?

Chapter Summary

- The improvements in supply chain logistics and the growing sophistication of logistics cost measurement have contributed to the growing competitiveness of food exports.
- These improvements have also contributed to lower prices and more choice for consumers.
- The concept of a trade-off between transportation and inventory costs within a logistics cost framework also has applicability for the measurement of the environmental impact of our food products.
- Just as businesses seek to minimize their costs across their entire supply chain rather than focus solely on transportation costs, we should seek to minimize environmental costs on the same basis.

The previous chapter explained some of the economics of supply chain logistics and how shippers use performance measures in making their supply chain decisions. But what does this all mean for the food industry, such as primary producers, processors, and food retailers? How do these decisions ultimately impact the consumer? And what supply chain information is relevant to food consumers?

IMPLICATIONS FOR INDUSTRY—SUPPLY CHAINS AND EXPORTS

We often hear that Canada’s food industry should become more export oriented, which would improve economies of scale and scope. However, these strategic discussions around orientation are often divorced from an understanding of the logistics of supply chains.

For industry, improvements in supply chain efficiencies open up opportunities in new markets. But these improvements often rely on policies and/or investments undertaken by Canada’s trading partners. In fact, for developed countries with advanced cold chain infrastructure already in place, keeping abreast of improvements on the other end is arguably more important than domestic logistics. For example, Canada exports nearly $400 million of fresh pork and close to $500 million of frozen pork to Japan each year.1 The fresh pork exports have been enabled through advancements in reefer and packaging technologies. Canada also exports pork to China, but most of that pork is of the frozen variety. (See Chart 2.) This is not only the result of higher average incomes in Japan—China lacks hinterland cold chain infrastructure. So while the logistics of getting fresh products to the port of entry in each country is similar, the “last mile” largely prevents such products making their way into Chinese markets. This is important to keep in mind in any discussion of growth or diversification of Canada’s food export markets.

1 Industry Canada, Trade Data Online.
This lack of infrastructure acts, effectively, as a non-tariff barrier to trade. These non-tariff barriers may also be institutional. Inefficient and unreliable customs and port processing may cause unacceptable delays in food product movements resulting in spoilage or reduced shelf life.

Similarly, gaps still exist in Mexican cold chain infrastructure, which prevents greater entry of both fresh and frozen products. Shippers would like to take greater advantage of rail to ship frozen products as well as fresh products. The low usage of rail freight for these purposes is not due to the lack of rail connections with the rest of North America. Kansas City Southern (KCS) serves all major Mexican markets and connects to the rest of the North American rail network in the U.S. South and Midwest. However, transit times to Mexico are high for rail shipments while domestic cold storage facilities are often not adequate to deal with inspection requirements. For example, the lack of fluid inspection facilities at the U.S.–Mexico border lengthens the railway transit time, increases the potential for cold chain breaks, and ultimately increases the cost of shipping products by rail.\footnote{Prentice, \textit{Refrigerated Transport of Canadian Agri-Food Products to Mexico}, 24.} As a result, Canadian exporters are often left with the prospect of shipping frozen products over significant distances by truck, at a large premium, or being left out of the market entirely.

Currently, Mexico imports over 750,000 tonnes of frozen food products each year, most of which are meat products. However, virtually all are imported by truck (76 per cent) or ocean transport (23 per cent). Similarly, most frozen food products exported from Mexico (mainly vegetables, fruit, and fish) are shipped by truck (66 per cent) or ocean transport (33 per cent).\footnote{Bilovesky, “Doing Business in Mexico,” 21–22.}

Those modal shares could change with the opening of an inspection facility at the Laredo crossing (the busiest surface border crossing into Mexico) in 2013 and a network of proposed cold storage warehouses in Mexico by KCS. These developments will increase the potential for modal shift from truck to rail. But, perhaps more importantly, they have the potential to alter sourcing decisions for Mexican importers, where meat and fish that are currently imported through the Southern ports may have new competition from similar products that are shipped by rail from the U.S. and Canada. Currently, Canadian producers send just 64,000 tonnes of meat to Mexican markets, largely due to the expense of truck transportation.\footnote{Haksteen, “Are You Taking Advantage of Rail?,” 12.}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{chart2.png}
\caption{Canadian Fresh and Frozen Pork Exports, 2011 ($ millions)}
\begin{itemize}
\item \textbf{Fresh or chilled}
\item \textbf{Frozen}
\end{itemize}
\end{figure}

\textbf{Gaps still exist in Mexican cold chain infrastructure, which prevents greater entry of both fresh and frozen products.}

In these cases, the key point for domestic exporters is that foreign hinterland infrastructure improvements can create significant opportunities (or threats). And while the exporter may not always have an opportunity to influence the likelihood and timing of those improvements, awareness of when and where improvements are occurring is in itself valuable. Explicitly estimating the impact of these changes on the delivered price of food products through the use of a logistics costs model can provide individual shippers interested in taking advantage of new opportunities with an indication of their potential competitiveness.
GROWING DRY FOOD EXPORT OPPORTUNITIES

Pulse crops, such as dry beans and lentils, have trended toward containerization. As mentioned, shipping in containers reduces the amount of handling and is better suited for maintaining product integrity as a result. In addition, as with cold chain infrastructure, grain-handling infrastructure is often weak in developing countries. Containerizing grain products helps to overcome this weakness and opens up new market opportunities. Shippers are taking advantage of this now, by shipping containerized pulses to distant markets such as Indonesia and North Africa through the ports of Montréal and Halifax, which have invested into “tip and load” facilities for the purpose of containerizing grain products.5

Although Canada’s pulse crop exports have exploded (exports of dry peas are expected to be 2.4 million tonnes in the 2012–13 crop year and lentil exports are expected to be 1.4 million tonnes—by value, the export of these crops has nearly doubled over the past five years6), there is room for even more growth. The largest markets (India in particular) continue to grow both in terms of population and wealth. (See Chart 3.) In addition, Canadian pulse products are predominately food grade (rather than feed grade) and command a premium as a result. However, lack of container availability could stymie further growth of pulse exports from Canada.

India remains the largest producer as well as consumer of pulses. We noted earlier that the development of foreign hinterland infrastructure can provide opportunities for domestic exporters. But it can also pose a threat because countries, such as India, that lack inland infrastructure have difficulty delivering their own products to domestic consumers. Developing this infrastructure and competence could to some extent obviate the need to import similar products.

Canada can continue to serve and expand its pulse export presence in the Indian market if it can efficiently manage its domestic supply and reposition international containers. If Canada can efficiently develop its infrastructure, this will effectively change the economics of hinterland development in India (since shipping in containers helps to maintain product integrity through slow-moving and less reliable supply chains). However, this advantage can evaporate if hinterland infrastructure development in India begins to tip the balance in favour of its own domestic producers moving product in bulk within the country. In this sense, Canada’s food supply chain infrastructure development can be considered a competitive advantage for Canada.

EXPORTING PROCESSED FOODS

Several factors add to the complexity of exporting processed foods beyond transportation and logistics factors, such as marketing and brand barriers. But transportation does play a role as, by definition, value is added to the product after it is processed, which in turn increases the total logistics cost of shipping the product. As a result, it is often more economical to export raw or semi-processed food products and then process and/or customize the product closer to consumption markets.

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5 Port of Halifax, Cargo.

6 Agriculture and Agri-Food Canada, Canada: Pulse and Special Crops Outlook.
IMPLICATIONS FOR CONSUMERS

We often hear about the lack of productivity growth in Canada and the corresponding negative impact on our incomes. While there is a lack of overall productivity growth in general, there are numerous examples of supply chain productivity improvements that have resulted in benefits for consumers of food (in other words—everybody). The cold supply chain improvements and the logistics decisions that go along with those—described in Chapter 2—are prime examples. But how exactly do these improvements and choices affect consumers?

Reducing transportation and logistics costs through efficiency improvements has the same effect on trade as reducing tariffs and other barriers to trade. It allows for increased competition, for producers to specialize in what they do best, and for consumers to enjoy greater choice and lower prices. This applies not only to international trade, but to domestic trade as well (trade between provinces, cities, or even neighbourhoods—trade that is just as important but is rarely defined as such).

This phenomenon is particularly important for food. Some foods such as spices and tea have been traded internationally for centuries. But consumers have only very recently been able to reap the benefits of widespread trade in perishable foods. As explained in the box “A Chronology of Advancements in Temperature-Controlled Food Cargo,” widespread temperature-controlled food trade largely developed in the mid-20th century and has grown steadily since.

The particular benefit of lower food prices is evidenced in part by food’s declining share of household spending in Canada, as explained in another recent Centre for Food in Canada (CFIC) report. Furthermore, the share has been declining across all income groups. While the data show a relatively modest (but important) decline in this share over a fairly short period, the impact over a longer period is enormous. For example, U.S. data show that food’s share of household spending declined from over 40 per cent in the early 20th century to under 20 per cent for an equivalent family in the 1980s.

These and consumer price index (CPI) data do not capture all of the welfare benefits that consumers have been able to reap as a result of logistics and other efficiency gains. For example, the eastern U.S. consumers who desired crisphead lettuce not only benefited from lower prices when the logistical kinks were eventually worked out (working reefer cars), they also benefited from greater seasonal availability of the lettuce and greater variety of lettuce types (and other foods). In economists’ jargon, some of these benefits have been “monetized” by consumers in the form of a switch to a higher quality or larger variety of food that we consume (income effect). (See box “Consumer Food Price Measurement—Outlet Substitution Bias and Other Factors.”)

These benefits are difficult to capture with data that rely on price indices developed by statistical agencies, but they are no less real or important. There has been a growing interest in capturing some related effects in inflation estimations through observations of how willing

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A Chronology of Advancements in Temperature-Controlled Food Cargo

- Mid-1800s: Ice-filled rail cars
  - The James Dean method
- Early 1900s: Refrigerated rail cars/trailers, reefer ships
  - Introduced better temperature control performance and ability to ship over longer distances
- 1960s: Refrigerated intermodal containers
  - Minimized handling and potential for cold-chain breaches as a result, greatly expanded international shipping
- 1990s: Multiple-temperature-zone trailers
  - Decreased minimum shipment sizes required for domestic/continental shipments
- 2000s: Multiple-temperature-zone containers
  - Decreased minimum shipment sizes required for international shipments

Source: The Conference Board of Canada.

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7 The Conference Board of Canada, The Sky’s the Limit.
Consumers are to pay for specific attributes of products.9 But when it comes to data produced by statistical agencies, this technique has often been reserved for measuring quality change in information communications technology.10 Some estimates of upward CPI bias for food products in Canada due to outlet substitution bias have been conducted,11 but these estimates also do not attempt to capture the value of the year-round availability of a larger variety of foods.

Potentially, we can apply these techniques to food products by including seasonal availability as a product attribute while considering the diversity of food products available in any given urban area as an increase in quality.12 The key point is that we as consumers like, and indeed expect, a variety of foods to be available at virtually all times. For example, the average number of products carried in a typical grocery store in the U.S. has increased from 30,000 to nearly 50,000 in the last 10 years alone.13 We are willing to pay for this benefit as it gives us a better chance as individuals to eat what we like. But we often do not have to, thanks to efficiency gains and competition among producers. Many of these benefits are a direct result of cold chain improvements and the indirect result of the agglomeration economies generated by lower generalized transportation costs—in other words, directly attributable to improvement in food supply chains.

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9 Such as through hedonic regressions, which measure the change in the price of product attributes rather than by identifying “matched-models” from one year to the next, the latter being the standard approach to CPI calculations.


12 Although the problem of accounting for seasonal availability is largely isomorphic to the general problem of accounting for new goods in price indices, as pointed out by Alfred Marshall as far back as 1887.

Estimates of price changes in the U.S. retail food industry may indicate the potential magnitude of the impact of new market entrants into the Canadian market. For example, Walmart is increasing its presence in the retail food market in Canada, much as it did in the U.S., while Target continues to enter the Canadian market in 2013 and will be partnering with Sobey’s to supply food and grocery products in its stores. Both companies have been able to provide food items at lower prices in the U.S. due in large part to their ability to manage their supply chain costs.

Total grocery store sales in Canada were about $84 billion in 2010. If we assume a similar magnitude in price difference between traditional and discount outlets in Canada, then a market share of just 10 per cent by new discount entrants would result in nearly $1 billion in savings for Canadian consumers (after adjusting for quality).

**FOOD TRANSPORTATION, ENERGY CONSUMPTION, AND ENVIRONMENTAL IMPACT**

Efficient transportation and logistics help to overcome the natural trade barrier caused by the physical distance that separates buyers from sellers. But greater use of transportation services typically comes at the cost of higher energy consumption and a related negative environmental impact. For temperature-controlled commodities, there is an additional penalty due to the energy required to keep the commodities cool during transport and storage.

While energy consumption varies according to ambient temperatures and whether the product is chilled or frozen, on average, a reefer trailer consumes about 2.3 litres of diesel per hour. To put this into context, the engine of a typical tractor-trailer combination will consume about 40 litres of diesel fuel per hour while travelling. So, at a minimum, the additional energy cost while in transit is 5 to 6 per cent. However, reefer units need to be run continuously (for chilled products) whether the vehicle is moving or not. In addition, the products must be kept chilled or frozen while in storage.

**SUPPLY CHAINS AND ENVIRONMENTAL PERFORMANCE**

Supply chain improvements have provided Canadians with more variety and better prices than ever before. With those attributes well in hand, some consumers will shift their attention to other attributes, like the environmental footprint of their food. We see this in the CFIC household survey results, which revealed that nearly 80 per cent of Canadians stated that they considered the environmental impact of the food that they buy. (See Table 8.)

<table>
<thead>
<tr>
<th>Table 8</th>
<th>Response to CFIC Household Survey Question—When Deciding What Food to Buy, How Important Is the Impact on the Environment? (n=1,128)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td>Extremely important</td>
<td>136</td>
</tr>
<tr>
<td>Very important</td>
<td>379</td>
</tr>
<tr>
<td>Somewhat important</td>
<td>386</td>
</tr>
<tr>
<td>Not very important</td>
<td>139</td>
</tr>
<tr>
<td>Not at all important</td>
<td>88</td>
</tr>
<tr>
<td>Total</td>
<td>1000</td>
</tr>
</tbody>
</table>

Source: The Conference Board of Canada.

However, to act upon this preference (through a higher willingness to pay for foods with lower environmental footprints), consumers would have to understand the life cycle emissions of their food choices. This is because there is significantly more energy consumed during the production process of most foods, relative to the energy that is consumed while in storage and transit.

14 Powell, “Target Set to Steal Significant Share.”
15 Industry Canada, Retail Revenue and Expenses.
16 Ten per cent market share equates to $8.4 billion in sales (at currently observed prices). A 10 per cent quality-adjusted discount on this portion of the market equates to $840 million in savings. This ignores the potential impact that the presence of discount outlets may have on the incumbents.
17 Anonymous industry representative, phone interview by Vijay Gill, September 17, 2012.
18 The Conference Board of Canada, Centre for Food in Canada Household Survey.
This point was demonstrated quite thoroughly through research using an input-output life cycle assessment of the energy consumption and greenhouse gas (GHG) emissions profile of food that is consumed in the United States.\(^{19}\) That research showed that on average 83 per cent of the GHG emissions associated with food were generated during the production phase. As a result, focusing on minimizing the energy consumption and/or GHG emissions of the transportation phase can easily result in higher life cycle emissions if the alternate production source is even slightly less efficient.

The concept of life cycle emissions and the trade-off between production and transportation emissions is analogous to the concept of total logistics costs and the trade-off between inventory and transportation costs. For example, a food processor might centralize food processing and pick a specific plant location to minimize total logistics costs, but this might result in higher transportation costs. But if the food processor simply decentralizes production for the purpose of minimizing transportation costs, its total logistics cost may end up being higher due to the higher plant costs. The same can be said about emissions, where a narrow focus on the transportation emissions may help to reduce those emissions, but only with a disproportionate increase in emissions at the production stage.

Furthermore, it is not clear that localizing food production would even reduce energy consumption and associated carbon emissions from transportation. This is because local farms naturally result in lower population density in any given urban area. And people usually drive more in less dense cities.\(^{20}\)

Unfortunately, the narrowly defined objective of food miles has typically generated more attention than the seemingly mundane, albeit highly rigorous, methodology of “life cycle emissions.” As a result, what could be heralded as a major contributor to higher quality of life has often been demonized for the very aspect that allows for those benefits—the safe and efficient transportation of food over vast distances.

**HOW ABOUT “FRESHNESS AND TASTE”?**

The level of “freshness” does not directly relate to the time elapsed since harvest. For example, fruits and vegetables are still alive after they are harvested. While in storage and in transit, they continue to respire (breathe) and transpire (sweat). Slowing the rate of respiration and transpiration slows the physiological aging of the food.\(^{21}\) Moreover, many fruits, such as bananas, are harvested prior to ripening and transported in their green state. Ripening occurs in transit and is generally completed after delivery with the aid of a ripening agent such as ethylene.\(^{22}\) Thus, if freshness is defined by the level of physical deterioration of the fruit after ripening, the time spent in transit is irrelevant.

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**Focusing on minimizing the energy consumption and/or GHG emissions of the transportation phase can result in higher life cycle emissions if the alternate production source is even slightly less efficient.**

This hastens a discussion of what freshness actually means. In the context of temperature-controlled transport, fresh foods are simply those that are never frozen. Consumers associate the term with a range of attributes, which typically correspond to the physiological aging and physical characteristics of the food. Consumers who are aware of the physical origin of the food are more likely to cite the non-physical characteristics of the food as an indicator of freshness.\(^ {23}\) In other words, consumers typically need to be made aware of the location of production in order for that to become a factor in their perception of freshness. Since foods that are maintained in optimal temperature-controlled environments while in transit or storage physiologically age more slowly, the meaning of freshness in physical terms becomes disassociated with time or distance from origin. For example, a 2°F difference can reduce the freshness of lettuce and resulting shelf life by more than one day. (See Chart 4.)

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\(^{19}\) Weber and Matthews, “Food-Miles and the Relative Climate Impacts of Food Choices.”

\(^{20}\) Sexton, “The Inefficiency of Local Food.”

\(^{21}\) Institute of Food Science and Technology, *Fresh Fruit and Vegetables.*

\(^{22}\) Australian Bananas, “Ripening.”

\(^{23}\) Péneau, *Freshness of Fruits and Vegetables.*
If transported in an environment that is not temperature controlled, a locally sourced product can in fact be less fresh than one that has been transported over a longer distance. This development is a direct result of the technical and operational advances that have been made in the cold chain. After all, consumers in New York would not need to have been made aware of the origin of James Dean’s soggy lettuce in order to determine that it was not fresh. In other words, there is less to distinguish between products of different geographic origins than we are often led to believe.

With that said, cold chain breaks do still occur and food quality is compromised as a result. While instances of breaks during the transportation stage are increasingly rare due to the reliability of the equipment and real-time temperature monitoring, human error and less reputable companies trying to save money can still cause this to happen. This reinforces the need for shippers to deal with reputable companies and/or maintain active monitoring and control of temperature-sensitive shipments. And, as demonstrated in Chapter 2, through the application of a logistics cost model, shippers have large financial incentives to avoid cold chain breaks.

**SYNOPSIS**

Why should consumers care about the efficiency of our food supply chains? The simple answer is that more efficient supply chains result in lower prices and a larger variety of food products being available.

In order to influence the speed of efficiency improvements, consumers need only to vote with their wallets (or stomachs). However, there are certainly implications for the efficiency of our food supply chains, and the resulting price of the products, as a consequence of public policy decisions.

For example, many retail stores (food retailers and otherwise) would like to move to nighttime delivery of certain products to avoid congested road conditions and to reduce competition for daytime delivery capacity in local markets. However, these efforts are often handcuffed by municipal laws dealing with noise restrictions—even when those restrictions did not emanate from local complaints.

While such restrictions are often necessary to balance conflicting interests, in this case the beneficiaries of the restrictions (local residents) also largely absorb the costs as they likely shop at these local outlets and drive on the congested local roads. Demonstrating the impact on consumers of local policies that hamper supply chain efficiencies may help to make the case for more relaxed restrictions in certain cases.

Industry too, has to care about food supply chains. As we have shown, food markets cannot be disassociated from their supply chain networks. The markets the food companies serve and their economies of scale and scope are determined by supply chains.

24 Rossen and Ayala, “Rossen Reports.”

Chapter 4

Strategic Considerations for Food Companies

Chapter Summary

- Improvements in food supply chain logistics allow a given producer to reach more markets. But they also potentially bring new entrants into that given producer’s existing markets.
- As a result, changes that affect food supply chain costs provide both opportunities and threats for current producers.
- For cold chains in particular, the first and last mile of the supply chain are especially important. There is a need then, to keep abreast of infrastructure and other improvements on the domestic and foreign ends of international supply chains.

Strategic challenges facing food companies differ depending on where the companies are in the wider food product supply chain. For example, live animals farmed in Canada are, for the most part, shipped within North America. In Canada, our relatively efficient domestic supply chains have helped to bring grain products to world markets. Meanwhile, domestic food processors have opportunities to add more value to their product (higher-quality foods, prepared foods that are convenient for consumers, etc.) and rely upon efficient upstream and downstream supply chains to get these products to market. Domestic retailers are, by definition, here to serve the local market so their ability to increase market share is relatively limited and increasingly under attack from new competition looking to apply their own supply chain expertise to capture market share.

Competition varies greatly by product. The production and international trade of some food products are dominated by a small number of countries, while for others there is a more uniform distribution of production. This happens for a number of reasons. Perhaps the most obvious is the availability and natural fertility of the land required for production (e.g., to produce fruits and vegetables). Regulations and the degree of trade restrictions or openness are others. And the location of large populations and their associated tastes in foods can favour production in one location over another—even though this is also related to transportation and logistics efficiency as well.

As noted in Chapter 2, one factor affecting distribution is the shelf life of the product itself. For example, kiwi fruit maintained at a temperature of 0°C has a shelf life of up to three months. On the other hand, strawberries will last no more than eight days with the same optimal temperature. This difference helps to explain why strawberries rack up frequent flyer miles while kiwi fruit are moved much more slowly by ocean shipping. Remember the food service-level pecking order?
Naturally, density is not the sole reason for export concentration. In fact, political considerations often govern where and how food is traded. Supply management of dairy products in Canada is one such example.

A number of other factors can also contribute. For example, the relative yields of particular agricultural products between different countries (or regions within a country) are important. If only a few countries are able to achieve a high yield, they will naturally have an advantage. The seasonality of the product is another influence. So is the density of the food; more specifically, the value density—the ratio of value to weight—of the product. A food product with a relatively long shelf life may not be as conducive to export concentration if it is also less value dense, due to the altered significance of shipping costs. This may explain in part why kiwi fruit exports are dominated by so few countries compared with apple exports.

**Table 9**
Value Density (US$/kg), Shelf Life, and Market Share

<table>
<thead>
<tr>
<th>Product</th>
<th>Value density (US$/kg)</th>
<th>Shelf life at optimal temperature</th>
<th>Market share of top three countries (per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apples</td>
<td>0.69</td>
<td>Long</td>
<td>38</td>
</tr>
<tr>
<td>Green beans</td>
<td>1.24</td>
<td>Short</td>
<td>40</td>
</tr>
<tr>
<td>Strawberries</td>
<td>2.41</td>
<td>Very short</td>
<td>60</td>
</tr>
<tr>
<td>Kiwi fruit</td>
<td>1.43</td>
<td>Very long</td>
<td>77</td>
</tr>
</tbody>
</table>


Competition is also impacted by the extent to which the growing season varies by geographic area. For example, British Columbia seed fruits (e.g., cherries) command a high price in export markets since by the time these crops ripen and are ready for export in mid- to late summer, the crops in more southern climates (such as Washington state) have already been exported and consumed.

Changing geographic distribution of demand is also a dominating factor that may be masking some of the impact. For example, demand for meats was once concentrated in the rich industrialized countries in the West whereas now the demand is more geographically dispersed.

Here we consider the shelf life and value density of four specific fruits and vegetables in relation to the concentration of market share by country (see Table 9):

- Apples—Top three countries (Italy, France, and the U.S.) have 38 per cent of the world export market by value.
- Green beans—Top three countries (France, Kenya, and Spain) have 40 per cent of the world export market by value.
- Strawberries—Top three countries (Spain, U.S., and the Netherlands) have 60 per cent of the world export market by value.
- Kiwi fruit—Top three countries (New Zealand, Italy, and Belgium) have 77 per cent of the world export market by value.

See Appendix A for additional detail on the top exporting countries for each of these products.

Due to the value of the product, strawberries are more conducive to being shipped by air. This contributes to the potential for export dominance by fewer countries despite the short shelf life. Kiwi fruit are not as value dense, but the long shelf life under optimal storage conditions lends itself to export dominance.

**IMPLICATIONS: LOW HANGING FRUIT AND FLYING FISH**

The foods with a longer shelf life are the “low hanging fruit.” With just reasonable supply chain logistics competence and infrastructure, countries that produce these products have been able to expand their market share. Trade patterns for foods with shorter shelf lives will
likely have greater potential for change due to incremental improvements in the supply chain. This can create opportunities for domestic producers but can also threaten domestic producers that rely primarily on domestic consumption for market share.

For example, as explained in Chapter 3, India is both a large producer and consumer of pulse crops. But the country has an abundance of arable land (over 50 per cent) and the variety of seasons for the production of a range of fruits and vegetables as well. However, it is unable to take full advantage of this capability for export growth (or even domestic consumption) due to a poorly connected hinterland infrastructure and a general lack of cold chain capabilities. These are in part the same factors that have made Canadian pulse exports to India so lucrative. But if and when India is able to make even rudimentary improvements in its infrastructure, it can potentially alter trade patterns for a number of the low-hanging fruit agri-food products (even with lower farm yields).

India is unable to take advantage of its arable land due to a lack of efficient infrastructure and cold chain capabilities.

On the other hand, incremental improvements are more likely to open up opportunities in the higher-valued (short shelf life) food product markets. For example, companies in British Columbia and Atlantic Canada export fresh fish to Mexico by air (yes—fish can fly). However, British Columbian producers can take advantage of direct flights from Vancouver to Mexico. This is a by-product of passenger traffic demand, as the freight moves as belly cargo. On the other hand, Atlantic producers must move product LTL to Toronto first, where it is then shipped by air. This is much more expensive and the transit time is longer. Thus, an incremental change, such as more frequent air service from a closer airport, could alter the dynamics of the market. The implications are the same for food importers—small changes can result in certain products being considerably more viable for import.

UNDERSTANDING THE COLD CHAIN, TRADE-OFF BETWEEN CONTAINER AVAILABILITY, AND RESOURCE COSTS

Chapter 2 explained that intermodal container supply and positioning poses a problem for Canadian exporters. This problem is particularly acute for exporters of perishable products, as reefer containers are significantly more expensive to own and operate. One answer for shippers would be to own more of their own containers rather than rely on the availability of those owned by shipping lines. However, as costly as it is for shipping lines to own and operate reefer containers, it would likely be even more expensive for shippers, as they would be in a worse position to ensure adequate container utilization.

Regardless of who owns the container, communication is the key. Better and faster flows of information between supply chain participants will have an impact similar to having the entire supply chain owned and managed by a single entity.

One tool that shipping lines use to convey information of the costs of delay is a demurrage charge. This is the charge to the shipper for late return of the container (or excess loading time). A typical demurrage charge for intermodal containers is $100 or more, with reefer containers often carrying demurrage charges that are significantly higher. In a perfectly competitive market, the demurrage charge would be the same price a shipper would “charge” to itself for delay. But this cost varies rapidly from day to day and place to place. As a result, a relatively fixed demurrage charge cannot be perfectly efficient and we have some degree of information asymmetry.

Recent cold chain tracking technological developments are filling this gap to some extent. Rail freight carriers are investing in solutions that will increase the visibility of rail-based cold supply chains. Continental tracking technology, which relies on the use of GSM networks rather than satellite-based communications, has become significantly cheaper, with some solutions now starting at roughly $16 per month rather than $100 or more per month.

1 Viswanadham, Can India Bethe Food Basket?, 1.
2 Prentice, Refrigerated Transport of Canadian Agri-Food Products to Mexico, 10.
3 Anonymous industry representative, phone interview by Vijay Gill, August 13, 2012.
OPPORTUNITIES AND THREATS FOR CANADIAN PRODUCERS

CONTAINERIZATION AND SMALLER EOQ—BREAKING ECONOMIES OF SCALE
There has been a major shift in ocean shipping of temperature-controlled food products from reefer ships to container ships with slots for reefer containers. This shift continues today (reefer container capacity continues to grow while there are no standing reefer ship orders). As done for other commodities, containerization has reduced the economic minimum order quantity (down to one container load), potentially disrupting the traditional advantage of economies of scale as a result. This lowers barriers to entry into specific markets and opens up the opportunity for a greater variety of products in any given market.4 It has also increased the frequency and predictability of temperature-controlled food product delivery options since there are many more container ships than reefer ships and they typically operate on schedules. A similar shift is occurring in air transport, between belly cargo on passenger planes and all-cargo air freight movement.

As noted in Chapter 2, it appears that rail freight carriers are poised to cause another incremental shift in this direction for perishable products through the deployment of clip-on generator sets for reefer units. Given the potential freight cost savings from truck to rail, this can tip the balance in favour of some niche exporters that are not located in dense urban markets.

CONTINUED OVERALL GROWTH IN SUPPLY OF TEMPERATURE-CONTROLLED CONTAINERS
The worldwide reefer containers fleet of 300,000 20-foot equivalent units (TEU) in 1990 had increased to 800,000 TEU in 2001.5 The total fleet now sits at 1.7 million TEU.6

Again, this overall trend creates the opportunity for more niche opportunities. The dynamics of the liner shipping industry allow for relatively small producers to ship container loads to most parts of the world. This also contributes to the overall potential for greater retail competition from non-traditional food retailers, as they are already large customers of ocean carriers with supply chains that make significant use of intermodal containers.

NEXT STEPS IN THE FOOD MODAL CHOICE PECKING ORDER
The increasing value of specific food products means greater opportunity for expedited freight. This partly offsets the increase in the delivered price of the product, due to lower inventory and handling costs.

Certain grain products are natural candidates to move in this direction, such as the pulse products mentioned in Chapter 2. As prices increase, canola shipping may also continue to lend itself well to being shipped in containers. Since domestic repositioning of containers and container availability in general is an issue for grain exporters, there may be some scope for collaborating with importers that make use of these containers (such as domestic retailers), as better backhaul use of these containers should ultimately mean better container rates for importers.

Containerization has reduced the economic minimum order quantity (down to one container load), potentially disrupting the traditional advantage of economies of scale.

For example, grain-producing regions face difficulty in obtaining container capacity in order to make containerization of their products more feasible, whereas domestic importers in the larger consumer markets are faced with the opposite problem in terms of the lack of backhaul (export) products. These domestic importers demand a significant amount of containerized consumer goods from Asia-Pacific markets through Port Metro Vancouver (and to a lesser extent the Port of Prince Rupert). On the backhaul, empty containers may literally pass through the grain-producing regions empty on the way back to the Asia-Pacific markets. Any collaboration that helps to reposition these containers quickly and efficiently could help both domestic importers and exporters to achieve better container rates.

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4 Rodrigue, The Containerization of Commodities, 19.
5 Schenck, “Maersk Brings Automation.”
6 World Shipping Council, Global Container Fleet.
AIR FREIGHT OPPORTUNITIES

In general, the dedicated international air freighter market (rather than belly cargo that is carried by passenger aircraft) serving Canada is limited. Recently, Cargojet began to operate a dedicated freight out of Halifax to serve the European market, primarily for the purpose of shipping seafood. The problem with dedicated freighters is often the lack of backhaul traffic. In this case, Cargojet has been delivering to Brussels (where there is a large demand for seafood from the Maritimes) before ferrying over to Cologne to pick up European exports for backhaul.7 Given the highly time-sensitive nature of the product, this is a potentially large advantage for Eastern Canada shippers (with the alternative often being trucking the product to Montréal first).

However, dedicated air freighters have come and gone in the Canadian market, and shippers are often reluctant to abandon their current (less efficient) routing options in favour of new services, as there is no guarantee they will stick around (which itself makes it more difficult for new services to survive).

Food product shippers around the world are taking advantage of air freight in many ways that were previously unimaginable. For example, New Zealand’s role as a dairy exporting powerhouse is well known. Most of what the country exports in terms of milk products are dried products (such as powdered milk). Recently, shippers from New Zealand’s larger neighbour—Australia—planned air freighting 110,000 litres of fresh milk to China on a chartered 747.8

How is this potentially viable? The lack of fresh milk in the Chinese market is one reason. As a result, the premium on the milk (expected to be sold at a price of $5 to $7 per litre) can carry the additional cost of air freight. And because there is a large market in close proximity to the airport in Shanghai, the time penalty is not large. In fact, where it often takes up to 15 hours to get fresh milk to capital cities in the domestic market by road, the flight to Shanghai is only 10 hours or less, making door-to-door times similar.9 Because of the relatively small volumes that air freight offers relative to other transportation modes, one large market for a single product can make a dedicated flight viable.

Consider the total revenue carried by such a flight, relative to a passenger flight on a similar aircraft. A passenger flight on a similar-sized Boeing 747-400 could expect to carry roughly 500 passengers, depending on the mix of seating classes offered. Assuming a load factor of 80 per cent and an average ticket price of $1,000, each flight could be expected to generate about $400,000 in revenue.

With a dedicated milk run carrying 110,000 litres of milk (with no variation in load factor), the upper limit on the revenue will depend on the differential in fresh milk prices in Australia and China. With milk prices in Australia at approximately $1.50 per litre,10 this leaves a margin of $4.50 per litre if prices in China average $6. In this situation, the maximum revenue that can be generated in order to cover the additional logistics to reach the Shanghai market is $495,000, which is somewhat more than what the passenger flight would have generated.

SYNOPSIS

Canadian producers of oil and gas have been exploring all avenues to get their product to international markets in order to fetch a higher price. At the same time, international buyers are looking to tap new supplies so they can

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7 McCurry, “Canada’s Rocky Cargo Landscape.”
8 Smith, “Aussie Milk Headed for China.”
9 While it might seem that Australian producers have a distinct logistical advantage relative to Canadian producers in this regard due to distance, the flight distance from Sydney to Shanghai (approximately 7,900 km) is in fact only slightly shorter than the flight distance from Canadian cities such as Vancouver (9,000 km) and Calgary (9,400 km).
10 Numbeo, Cost of Living in Australia.
land a lower price (the natural corollary). Transportation and logistics efficiency, or the lack of it, is the cause for this differential in price. Massive investments will be required to better connect buyers and sellers of these energy products.

By comparison, relatively minor investments can result in connecting buyers and sellers of food products. The extent of the investment or logistical efficiency improvement required depends largely on the specific characteristics of the food products in question. And just as buyers and sellers of oil and gas need to be wary of the impact of major pipeline investments, food producers, processors, and retailers need to be aware of the relatively small changes that can affect the markets of the products they buy and sell.
Chapter 5

Conclusions

**Chapter Summary**

- Using supply chain efficiency metrics to evaluate ongoing changes in supply chain and transportation options can help identify opportunities and threats as they happen.
- Both domestic and foreign hinterland infrastructure improvements can have major impacts on the cost and viability of moving food products from one place to another.
- Policy-makers can and should use parallel metrics to evaluate the effectiveness of public investments and public policies on supply chain logistics costs.
- Businesses can educate consumers on the environmental impacts of food products using a supply chain approach to widen the narrow focus that is currently only on the transportation impacts.

**RECOMMENDATIONS FOR IMPROVING SUPPLY CHAIN EFFICIENCIES**

Canada has come a long way since James Dean’s fictional demonstration of supply chain logistics. Today, we take it for granted that lettuce can be easily shipped over long distances. And new technology is allowing other food products to reach new markets, or reach them in different ways.

**1. USE SUPPLY CHAIN EFFICIENCY METRICS FOR EVALUATION**

In general, as important as it is for shippers (whether they are selling fresh or processed food, or buying retail food products to sell to consumers) to continually explore opportunities to increase supply chain speed and reliability, they also need to consider new opportunities to move down the service-level pecking order. This is because lower service-level options may have improved enough to make the sacrifice in service level small enough to be outweighed by the direct savings in freight costs.

For exporters in particular, new markets will continue to open up due to logistics improvements. While China is naturally seen as a nation that is consuming more, there is also the potential to export higher quality products. These opportunities can sometimes be generated due to logistical improvements, as demonstrated by the fresh/frozen pork example highlighted in Chapter 3. As these opportunities open up, first movers will be rewarded.

At the same time, those same improvements can threaten Canadian domestic exporters. This is because of the ability of lower transportation and logistics costs to act just as a relaxation of a trade barrier would—it generates the potential for greater competition in general. But identifying beforehand how much and where that new competition will come from is always difficult. Perhaps the best current example of this is the potential impact on trade flows of the Panama Canal expansion in 2014.

While the expansion is expected to decrease shipping...
rates between Asia-Pacific countries and the East coast North American markets by giving them more direct ocean-shipping options, the extent to which this will actually occur is still unknown.

In the very near term, there are potential opposing forces on the horizon. For example, ocean shipping rates for reefer containers are due for a very large and rapid increase, which could impact sourcing decisions for domestic retailers, tipping the balance in favour of continental suppliers. Once again, those that are most efficient and nimble with their supply chains will be shielded the most from the rapid increase in international container rates.

The impacts of all of these changes can be quantified through supply chain logistics cost modelling. Large shippers are likely sophisticated with their supply chain logistics cost measurement. Small and medium-sized enterprises are more likely to make these trade-offs intuitively. For them it may be worthwhile moving to explicit measurement or making use of expertise offered by third-party logistics providers who have made this more accessible for smaller firms.

2. REVALUE THE POTENTIAL FOR RAIL TRANSPORTATION OF FRESH AND FROZEN FOOD PRODUCTS

Many supply chain changes are based on logistics innovations, which are ongoing. In the very near term, remote temperature control and continuous monitoring for intermodal shipments will make rail-based supply chains a more viable option for smaller shippers and those located in more remote regions, and for niche products and for more fresh food products in general. This can create new market opportunities while threatening the market share of incumbents. And retailers that are first to make efficient use of these advances will hold an advantage in their own markets.

Moving more products by rail usually involves carrying more inventory because order quantities and transit times are longer. But the lower cost of capital (lower interest rates in general) should actually lend itself to this, at least for frozen food products (since for fresh products the shelf life dominates). A lower cost of capital lowers the cost of holding inventory, all other things equal. A denser product helps in this regard, and dense products take up less warehouse space for a given weight. So while the general shift in supply chain management has been to lower inventory levels, we have seen some reversal in this trend.

Moving to rail has one disadvantage and that is the lack of sidings for many facilities that receive the frozen or temperature-controlled goods, including transload facilities at the ports. If the sidings are not there, there has to be an additional handling (unload rail to truck, transfer to facility, unload truck, etc.)

3. ASSESS THE IMPACT OF DOMESTIC AND FOREIGN HINTERLAND INFRASTRUCTURE IMPROVEMENTS

Many food supply chains are global. Regardless of who owns the product—buyer or seller—as it makes its way through the supply chain, both the first and last mile of that supply chain are important for buyers and sellers. The implication for Canadian food exporters and importers is that foreign hinterland infrastructure can impact their viability as much or more than the efficiency of the domestic infrastructure.

Those that are most efficient and nimble with their supply chains will be shielded the most from the rapid increase in international container rates.

This point is particularly important for temperature-controlled commodities that have a greater chance of spoilage in the logistics chains in China and even more in countries with less developed logistics chains like India. Major exporters may send logistics teams to foreign countries to do due diligence on the service levels in those foreign countries, or will rely on the advice of third-party logistics providers if they do not have the in-house capability.

Primary producers, processors, and food retailers must set up their supply chains to be oriented not only toward where growth in demand (or supply of their inputs) will be, but also toward where infrastructure and other improvements that are largely out of their own hands will be.
For food retailers that import food products, keeping abreast of foreign infrastructure can influence sourcing decisions and help to reduce supply chain costs as a result. In Canada, food retailers are increasingly seeing their market share come under attack by non-traditional food retailers (discount and club stores like Walmart) that are experts in evaluating such decisions for their traditional product supply chains. If the experience from the U.S. (where this phenomenon is more mature) holds true in Canada, these newer entrants have the potential to capture 10 per cent or more of the market share. This comes as a result not only because of highly efficient supply chain practices, but also because they are able to take advantage of their existing efficient non-food product supply chains. This is because cold-chain logistics improvements allow the movement of perishable products to look more and more like the movement of high-value and time-sensitive consumer products—products already handled with high efficiency by these players.

4. INCREASE COLLABORATION BETWEEN IMPORTERS AND EXPORTERS

The fortunes of food importers (primarily domestic retailers) and food exporters (both primary producers and processors) are tied together because they share the logistics infrastructure. For example, ocean shipping lines own many of the containers that are used for importing and exporting goods to and from Canada. The longer the container is held in Canada in order to be repositioned and find a backhaul shipment, the more it adds to the shipping lines’ container ownership costs. As a result, the shipping lines will charge customers directly for the extended use of these containers in order to provide an incentive to cycle the container as quickly as possible.

The Canadian railways have been successful to some extent in implementing domestic container repositioning programs. But if carriers, shippers, and infrastructure providers are able to collaborate to make the domestic repositioning of containers more efficient, this will increase the potential for Canadian grain products to reach lucrative foreign markets, while at the same time reducing the cost of importing products for the importer (since the container would be earning yield on both directions of the container movement).

And to some extent, these collaborative efforts “compete” with logistics improvements on the other end (foreign ports or hinterland), as they both reduce the cost of shipping products from point A to point B (or vice versa), as demonstrated by logistics cost modelling. An important distinguishing point is that efforts and investments that improve the efficiency of the Canadian portion of the supply chain also improve the efficiency of moving products from Canada to all parts of the world (and vice versa), whereas improvements on the other end of the supply chain improve efficiency to and from that country to everywhere else (including Canada).

Although domestic repositioning of international containers may seem to be a problem for ocean carriers to handle themselves (since they own them), there are many players in the domestic market that can influence how lucrative it is (or is not) for ocean carriers to let their containers stray further inland or spend more time inland. This includes the ground carriers (both rail and truck), ports, shippers, and providers of public infrastructure—anyone who can influence the speed and efficiency with which goods or empty containers can move from one point to another. And even where they are not directly involved with providing infrastructure, municipalities have the ability to (and often do) hinder goods movement with short-sighted restrictions on service in order to appease local interest at a great cost. In short, global issues require global thinking and if local interests have difficulty understanding that then it’s in part up to municipal leaders to educate them.

5. MEASURE SUPPLY CHAIN EFFICIENCY AT THE MACRO LEVEL

As noted, large or sophisticated food companies will typically measure their supply chain logistics performance with logistics cost or other models. Others will make transportation and inventory trade-offs less explicitly, but still based on the same fundamentals.

Governments are tasked with making infrastructure investment decisions and regulatory changes that will also affect supply chain logistics costs. In order to understand the impact of these decisions and measure the related cost or values, policy-makers need to consider the same fundamentals. As such, they should evaluate
the supply chain performance using system-wide supply chain metrics that are based on the micro foundations of supply chain logistic cost modelling.

For example, Transport Canada has initiated steps toward this type of system-wide supply chain performance measurement for goods movement in general. This framework will allow the federal government to measure the impact of its own investments on goods movements to, from, and within Canada based on how they impact the speed and reliability of goods movement supply chains. This effort should be expanded to develop specific performance measures for the movement of dry and temperature-controlled food products.

This type of analysis may even demonstrate the potential viability of unconventional investments. For example, perishable food product prices are at least double the cost in remote Northern communities as the same goods in the South. This is the result of limited transportation options and the high cost of air freight and trucking on winter roads. Some researchers have suggested that hybrid airships could prove to be a viable option due to their logistics cost advantage in those cases.

6. EDUCATE CONSUMERS ON THE BENEFITS OF FOOD SUPPLY CHAIN LOGISTICS IMPROVEMENTS

Finally, consumers are the ultimate beneficiaries of supply chain improvements. They benefit from a greater variety of foods at costs that are lower than they otherwise would have been. As taxpayers, they also benefit from the efficiency improvements of domestic businesses that come as a result of supply chain logistics improvement (hence the need to adequately balance the local and global interests mentioned above).

While Canadian consumers often feel that they are environmentally conscious when it comes to their food choices, they will need a more sophisticated understanding of what determines the environmental footprint of their foods so they can effectively act on this concern. Due to the relative energy consumption and associated emissions of the production and transportation components of food supply chains, simply relying on local origins of food products is an inadequate indicator of environmental performance. Since shippers already make use of sophisticated tools to measure total supply chain logistics costs, they can apply the same concept to illustrate the variability in the environmental impact of different food product choices that takes into account the whole food production chain.

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1 Transport Canada, “Measuring Supply Chain Performance.”
## Appendix A

### Additional Data on Market Share of Food Product Exports by Country

#### Table 1
World Apple Exports, 2005–09

<table>
<thead>
<tr>
<th>Country</th>
<th>Export quantity (tonnes)</th>
<th>Export value (US$ 000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>4,973,810</td>
<td>2,602,422</td>
</tr>
<tr>
<td>Italy</td>
<td>3,638,180</td>
<td>3,279,791</td>
</tr>
<tr>
<td>United States</td>
<td>3,516,215</td>
<td>3,211,253</td>
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<tr>
<td>France</td>
<td>3,318,124</td>
<td>3,121,345</td>
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<tr>
<td>Chile</td>
<td>3,584,034</td>
<td>2,292,837</td>
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<tr>
<td>Netherlands</td>
<td>1,992,983</td>
<td>1,798,944</td>
</tr>
<tr>
<td>Poland</td>
<td>2,394,398</td>
<td>886,874</td>
</tr>
<tr>
<td>Belgium</td>
<td>1,536,587</td>
<td>1,168,138</td>
</tr>
<tr>
<td>New Zealand</td>
<td>1,440,070</td>
<td>1,247,505</td>
</tr>
<tr>
<td>South Africa</td>
<td>1,561,892</td>
<td>1,003,490</td>
</tr>
<tr>
<td><strong>World total</strong></td>
<td><strong>36,803,847</strong></td>
<td><strong>25,501,362</strong></td>
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</table>

Source: United Nations, FAOSTAT.

#### Table 2
World Kiwi Fruit Exports, 2005–09

<table>
<thead>
<tr>
<th>Country</th>
<th>Export quantity (tonnes)</th>
<th>Export value (US$ 000s)</th>
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<tbody>
<tr>
<td>New Zealand</td>
<td>1,708,251</td>
<td>2,874,566</td>
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<td>Italy</td>
<td>1,635,398</td>
<td>2,009,115</td>
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<td>Belgium</td>
<td>544,214</td>
<td>1,293,571</td>
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<td>Chile</td>
<td>778,836</td>
<td>643,459</td>
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<td>Netherlands</td>
<td>164,790</td>
<td>275,717</td>
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<tr>
<td>Greece</td>
<td>198,582</td>
<td>183,702</td>
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<tr>
<td>France</td>
<td>127,415</td>
<td>244,158</td>
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<tr>
<td>United States</td>
<td>65,687</td>
<td>107,790</td>
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<tr>
<td>Germany</td>
<td>47,781</td>
<td>92,142</td>
</tr>
<tr>
<td>Iran (Islamic Republic of)</td>
<td>96,030</td>
<td>39,370</td>
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<tr>
<td><strong>World total</strong></td>
<td><strong>5,643,063</strong></td>
<td><strong>8,054,188</strong></td>
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Source: United Nations, FAOSTAT.
### Table 3
World Green Bean Exports, 2005–09

<table>
<thead>
<tr>
<th>Export quantity (tonnes)</th>
<th>Export value (US$ 000s)</th>
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<tr>
<td>France</td>
<td>352,116</td>
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<td>United States</td>
<td>160,809</td>
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<td>Spain</td>
<td>120,464</td>
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<tr>
<td>Kenya</td>
<td>94,136</td>
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<tr>
<td>Netherlands</td>
<td>173,079</td>
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<tr>
<td>Mexico</td>
<td>111,908</td>
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<tr>
<td>Belgium</td>
<td>71,284</td>
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<tr>
<td>Egypt</td>
<td>90,330</td>
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<tr>
<td>United Kingdom</td>
<td>71,030</td>
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<tr>
<td>Germany</td>
<td>39,184</td>
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<tr>
<td><strong>World total</strong></td>
<td><strong>1,690,151</strong></td>
</tr>
</tbody>
</table>

Source: United Nations, FAOSTAT

### Table 4
World Strawberry Exports, 2009

<table>
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<tr>
<th>Export quantity (tonnes)</th>
<th>Export value (US$ 000s)</th>
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<tbody>
<tr>
<td>Spain</td>
<td>224,618</td>
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<td>United States</td>
<td>130,027</td>
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<td>Netherlands</td>
<td>40,459</td>
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<td>Belgium</td>
<td>38,044</td>
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<td>Mexico</td>
<td>61,893</td>
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<tr>
<td>Egypt</td>
<td>66,992</td>
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<tr>
<td>France</td>
<td>22,950</td>
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<tr>
<td>Italy</td>
<td>17,000</td>
</tr>
<tr>
<td>Morocco</td>
<td>21,602</td>
</tr>
<tr>
<td>Germany</td>
<td>12,285</td>
</tr>
<tr>
<td><strong>World total</strong></td>
<td><strong>712,171</strong></td>
</tr>
</tbody>
</table>

Source: United Nations, FAOSTAT.
Appendix B

Bibliography


