# Economics Underlying Food Trade Patterns

Countries vary in their trade orientation because of underlying forces affecting supply and demand, some of which are not very well understood. Changing consumer preferences, geography, technology, and policies affecting market access all contribute toward shaping patterns of food trade. While recognizing that fundamental economic forces often change over time, trade patterns can be examined by focusing on such characteristics as product composition, trade balances, and product makeup of trading partners.

Patterns in food trade form when countries specialize in producing specific foods. Countries may export those products that make use of their abundant inputs. Specialization in food is also determined by the ability of the exporter to differentiate products. However, inputs required for producing and differentiating food vary widely by product. As globalization of the food industry enables firms to have easier access to capital and technology, the two most important inputs used in the production of many high-value products, the tendency of countries to specialize may become less predictable.

Food trade patterns have substantially changed for some countries in recent decades, making it difficult to discern future trends. For example, the composition of U.S. agricultural exports began to shift toward high-value food in the 1980s, with the rapid growth of markets in East Asia (Gehlhar and Coyle, 2001). Changes in the product makeup of U.S. exports led some to believe that the United States was becoming increasingly competitive in processed products and that the future of U.S. trade growth lie with high-value foods. These expectations were, however, tempered after U.S. exports of processed food slowed markedly (Carter, 2000). Fueling speculation and confusion are the frequent shifts between surpluses and deficits in U.S. high-value food trade.

Not all countries are characterized by unstable trade patterns. New Zealand, for example, is a consistent net exporter of specific high-value-foods. Its food exports, such as horticultural and livestock products, are dependent upon land and climate conditions ideal for growing crops and grazing animals. South Korea, by contrast, is a consistent net exporter of bakery products, even though it has scarce agricultural resources. Clearly, the production of some but not all high-value-food products is dependent on a country's natural resource endowment. This raises the question whether specialization patterns are stronger for products more closely tied to natural resources than for food products less dependent on land and climate.

A fundamental economic factor often motivating trade between partners is the resource endowment of each country. Differences in availability of natural resources generate incentives for specialization and product exchange. Such differences do not, however, explain why Canada, a food-surplus country having a resource endowment similar to that of the United States, recently became the largest importer of U.S. high-value foods. This bilateral trade pattern raises important questions about the nature of specialization taking place between countries endowed with similar production resources.

This study makes distinctions among various types of food products in order to provide clarity as to how and why patterns in food trade emerge. For example, viewing processed and unprocessed food trade in U.S. trade illustrates the importance of drawing economic distinctions among various types of products. The U.S. trade balances in these components are moving in opposite directions, suggesting that processed and unprocessed foods are affected by a unique set of economic factors (fig. 6). Using economic criteria, processed products can be further broken down into categories that enable us to better understand the nature and emerging patterns of food trade.

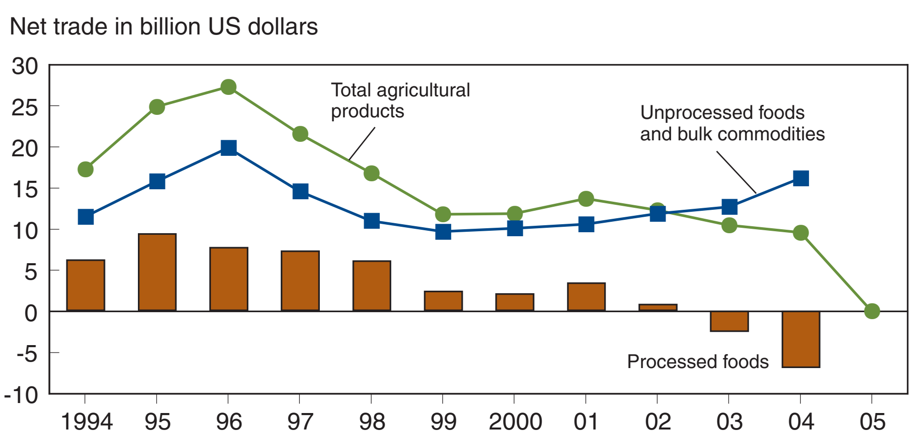
## Classification of Food Products by Economic Criteria

Any country can, in theory, engage in food processing given the availability of needed raw material inputs, labor, capital, and technology. Food manufacturers have the option of exporting to markets abroad or locating production close to sites of final consumption. Some manufacturing operations are strategically located to minimize distribution costs and enhance the ability to frequently replenish retail inventories. Timeliness of delivery is critical for inventory management, often subject to changing consumer demands. The economics of marketing finished food products tend to favor multiple manufacturing locations and relatively short distribution distances. Therefore, bakery, snack food, confectionery, and beverage industries often choose to manufacture close to consumer markets and are generally not export oriented.

Foreign direct investment (FDI) can play an important role in the location of food processing facilities. Increases in FDI in food manufacturing make production less location specific. International cross-ownership of assets becomes more common as global markets become increasingly integrated. In open economies, domestic firms can easily source their inputs from a

Figure 6

**U.S. agricultural trade surplus has been offset by a declining balance in processed food trade**




Note: Agricultural trade surplus for 2005 is projected.

Source: USDA, ERS.

foreign country and manufacture finished products locally to meet the needs of domestic retail markets.

The mobility of inputs employed in production also plays a role in the location of food production (see box on characteristics of high-value foods). Food processing and food manufacturing are distinct activities because of the mobility criterion that affects procurement costs (Atkins and Bowler, 2001). Food processing involves the "manipulation of raw materials into food products that retain characteristics of the original materials." Food manufacturing, by contrast, "is the transformation of agricultural raw materials into food products that have lost many of the characteristics of the original materials."

Land-based foods include not only all raw commodities, such as grains, fruits, and vegetables, but also some processed products, such as preserved fruits and vegetables, meat, and dairy products. The production location of land-based processed-food is influenced by product perishability, transportation costs, and geography. Frozen vegetables, for example, are classified as land-based processed foods since freezing facilities are typically located near vegetable-growing areas to minimize spoilage. High transportation costs and perishability can be used to classify raw vegetables, such as potatoes, as land based. The importance of geography in providing low-cost feed makes livestock products land based.

Manufactured foods can be produced almost anywhere investments are made in processing facilities. These goods are final consumer products and have relatively long shelf lives. Examples include breakfast cereal, infant formula, candy, beer, soft drinks, and other processed preparations. The location of manufactured-food production is not tied closely to the presence of natural resources. The raw ingredients of manufactured foods, such as refined sugar, starches, and grains, are relatively nonperishable and inexpensive to transport. These characteristics enable manufactured foods to be widely produced throughout the world.

Conceivably, some foods, such as poultry and beer, can be classified as either manufactured or land-based food. The location of poultry production may depend on natural resources, such as available area for bird waste disposal, and hence be considered a land-based food. However, poultry may also be considered a manufactured food because poultry feed is a widely traded input. In this study, a simple rule is used: as land is considered central to production, all meat and livestock are classified as land-based foods.

In comparison with poultry, beer can be brewed anywhere. The inputs used in beer production (malt, hops, and grains) are widely traded. Moreover, there are globally recognized licensing agreements for brand usage and brewing technologies. To minimize transportation costs, for example, a beer of Australian origin is brewed in Canada, where it is sold and exported to the United States under its Australian name. The mobility of brewing provides a rationale for beer to be classified as a manufactured food. Transportation cost considerations are, however, not always the most important factor driving production location decisions for beer. Several European breweries use the locality of beer production as a marketing strategy to

**Characteristics of land-based and manufactured high-value foods**

| | Land-based products | Manufactured products |
|---|---|---|
| Input characteristics | Sourced locally perishable, high transport cost | Sourced globally nonperishable |
| Input examples | Milk, live animals, fresh horticulture | Sugar, wheat, rice |
| Processing function | Preserving basic commodities | Transforming commodities |
| Processing examples | Freezing, canning, animal slaughter, | Blending, fermentation, cooking |
| Production location | Close to agricultural production<br><br>Supply oriented to minimize input cost | Close to consumer markets Location is demand oriented to minimize distribution cost of final products |
| Product examples | Frozen strawberries, meat, canned fruit | Confectionery, beer, bakery products |
| Extent of trade | Highly traded in global markets | Locally traded in regional markets |

differentiate their countries' beers. In this study, beer is, nevertheless, classified as a manufactured food since all of its raw material ingredients are economically traded goods.

## Trade Indicators

Information that reveals the importance of commodity and partner markets for exports may improve economic decisionmaking related to trade. Simple statistics, such as the net trade balance and trade shares, can be easily calculated and are readily transparent. However, these statistics provide little information about important economic dimensions of trade. For instance, they do not reveal a country's tendency to specialize in relation to other exporting countries. More sophisticated indicators are needed to reflect complexities not discernible in the commonly used trade statistics.

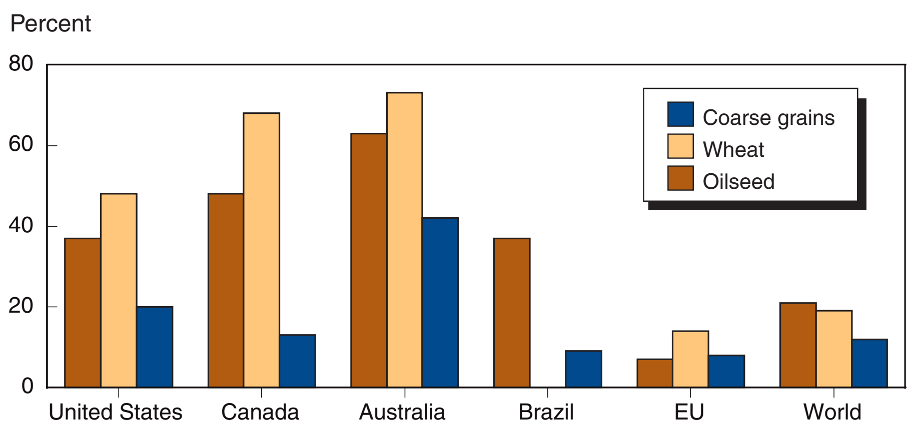
Three indicators, export share of production, revealed comparative advantage, and bilateral trade complementarity provide insights about the benefits of trade. Commodity export shares of production for the United States are routinely published by USDA. They depict the dependency of domestic producers on export markets. A country with a high export share of production stands to gain from improved market access, but it may also be vulnerable to global economic shocks. The revealed comparative advantage puts a country's agricultural exports in the context of the global market and total merchandise trade, placing in perspective the sector's economic performance in comparison with economic activity in the rest of the world. A change in this measure may or may not present a problem. But information about revealed comparative advantage can aid policymaker decisions regarding public investments in education, research, improving port capacity, and transportation networks. The bilateral trade complementarity index gauges how well a country's commodity export profile complements its partner's commodity import profile. This measure embodies national differences in factor endowments and variations in product demand. The complementarity index enables decisionmakers in an exporting country to identify national markets with whom it is likely to be highly advantageous to trade, based upon its profile of relative export advantages and the composition of partner imports across various commodities.

## *Export Share of Production*

The reliance of a country's agricultural sector on international markets is determined by the relative abundance of agricultural resources and the domestic demand for its agricultural outputs. This dependency can be measured for a given commodity or a product by the ratio of its total exports to its total domestic production. Canada has relatively high export-dependency ratios across a diverse set of land-based agricultural commodities, including both bulk and semi-processed products (figs. 7, 8). Canada exports about half of its total production of oilseeds and three-quarters of the total wheat production, much higher export shares than the global average rates of 15-20 percent for major bulk agricultural commodities. Canada also greatly exceeds the global average export-dependency ratios for oils and meals. Similarly, Australia is highly dependent on exports, and has dependency ratios that exceed the world average levels in three bulk commodities (wheat, coarse grains, and oilseeds) and two semi-processed products (dairy and meats). The export dependency of the United States and Brazil, two other major exporters of agricultural goods, exceeds the global average in four of these commodity groups. The EU, while a major exporter of agricultural goods, is less dependent on the export market for its land-based products than Australia, Brazil, Canada, United States, or New Zealand.

Figure 7

**Export dependency in bulk commodities, 1999-2003[1]**

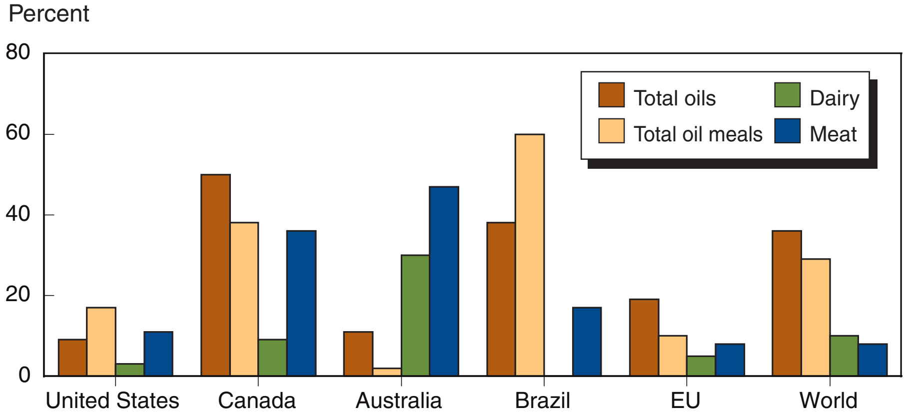



[1]Exports as share of total production averaged over the years.

Source: USDA, FAS, PS&D Database.

Figure 8

**Export dependency in semi-processed food products, 1999-2003[1]**




[1]Exports as share of total production averaged over the years.
Source: USDA, FAS, PS&D Database.

Oilseed products are the most internationally traded products when total exports are compared with global production. The dependency of oilseed producers on foreign markets would be even higher if trade statistics accounted for the oilseed content in all manufactured foods. Likewise, the export dependency ratios for producers of coarse grains and oil meals would be higher if one took into account the proportion of these products used to produce meat and dairy products.

The export orientation in processed foods also differs across countries. Although the EU and the United States have the world's largest food processing sectors, their export share (5 percent) of output is relatively small in comparison to that of developing countries (GTAP, 2001). Lower processing costs are often a source of comparative advantage for developing countries relative to industrialized countries, while modern technology, access to capital, and proximity to large markets are sources of scale economies for many developed countries. U.S. and EU consumers purchase a large share of their countries' domestically processed foods. Export earnings from processed foods are a larger share of food sector incomes in developing countries.

Export dependency does not necessarily reflect comparative advantage because it does not take into consideration the size of world trade. To gain a better understanding of U.S. relative trade advantage in agriculture, two specialized trade indices are used: the revealed comparative advantage (RCA) index and the bilateral complementarity index (see box on trade indices descriptions, app. C, and box on advantages and disadvantages of RCA indices).

## *Revealed Comparative Advantage*

The United States possesses a persistent RCA in agriculture despite changes in the composition of U.S. and world trade. This fact is evident from RCA calculations for U.S. agriculture, which are consistently greater than the comparative-advantage/comparative-disadvantage threshold of one (fig. 9). While there have been major shifts in the importance of bulk commodities

## Description of the Specialized Trade Indices

This report examines U.S. food in the context of global and bilateral trade using indicators that measure revealed comparative advantage (RCA), export specialization (XSP), import share (MS), and complementarity in the commodity composition of partner trade (CCD). Correlations are computed between XSPs for U.S. food exports and corresponding MS for its partner imports (app. C).

RCAs identify the extent to which an exporting country captures world market share in a particular area relative to the degree to which it captures export market share for all traded goods. An RCA greater (less) than one signifies a comparative advantage (disadvantage) for the particular item, while an RCA equal to one identifies neither. If, for example, U.S. agricultural exports are 25 percent of world agricultural trade and the United States capture a 20-percent share of all merchandise trade, then the U.S. RCA for agriculture is 1.25, revealing that the United States has a comparative advantage in this sector. This "revelation" assumes that there are no artificial impediments to trade, such as imperfect knowledge about market opportunities or policy distortions.

XSP is structured similarly to the RCA index. One difference is that the XSP focuses on an individual commodity, such as wheat, or a specific product, such as bread, within the food sector, whereas the RCA has an economywide focus that centers on foods in relation to total merchandise trade. An XSP greater (less) than one signifies a relative export advantage (disadvantage) for a specific product within the food sector; an XSP equal to one identifies neither.

The CCD index is a summary measure that links one country's XSPs with its trading partner's MSs across the spectrum of all traded foods within a designated food subsector (i.e., land-based or manufactured foods). A simple correlation of the two components of CCD generates a view of complementarity that matches U.S. relative export advantages for the various products within the specified food subsector with the importance of each food product in its trading partner's import basket. A positive correlation denotes bilateral complementarity in the product makeup of U.S. exports and partner imports in the particular food subsector. A negative coefficient denotes the absence of complementarity. In this case, U.S. export specializations and corresponding product import shares of the U.S. partner move in the opposite direction. A correlation of zero indicates no meaningful relationship.

in the composition of U.S. and world trade within the past two decades, the United States also reveals consistently stable comparative advantages in land-based foods.

In contrast to land-based foods, U.S. manufactured foods are not depicted as having a comparative advantage during 1989-2001. The RCA statistics for U.S. manufactured foods have, however, moved upward toward a value of one, showing a strengthened ability by the United States to export manufactured foods in recent years. This finding is not altogether surprising because

## Advantages and Disadvantages of Using RCA Indices

Comparative advantage is a central concept in economics. This concept focuses on the relative efficiency of producing different goods in the home country vis-à-vis the rest of the world. Theoretical expositions of comparative advantage show that unfettered trade across national borders results in countries making the best possible use of their domestic and foreign resources and available technologies. As articulated in a recent *Amber Waves* article, "a country should produce and export goods that reflect the relative abundance, and quality, of its land, labor, and capital resources" if it is to fully exploit economic comparative advantage (Dohlman et al., 2003).

The notion that countries can mutually benefit from trade if the relative prices of commodities differ between them in the absence of trade was first articulated by David Ricardo early in the 19th century. Ricardo provided a numerical example to illustrate his theory of comparative advantage (Ricardo, 1817). He demonstrated that even though England had higher per unit cost of production than Portugal in both wine and cloth, both countries could benefit from specialization and trade because England's cost disadvantage was relatively less for cloth.

Alternative theories of comparative advantage are based on (1) relative factor endowment (the Heckscher-Ohlin model), and (2) the differences in relative export supply and import demand (the neoclassical model) (Caves and Jones, 1981). Comparative advantage is dependent on numerous factors, some more easily measured and/or identified than others. For this reason, Balassa (1979) believed that more could be gained "if, instead of enunciating general principles and trying to apply these to explain actual trade flows, one took the observed pattern of trade as a point of departure." His reasoning was that comparative advantage could be "revealed" through the examination of real-world country/commodity trade patterns because cross-border trade "reflects relative costs as well as differences in nonprice factors." He, therefore, developed the revealed comparative advantage index (RCA). This index is a widely used indicator of comparative advantage (*http://unstats.un.org/unsd/comtrade/mr/rfReportersList.aspx*). RCA denotes relative efficiency indirectly, based on trading patterns that emerge from actual market transactions.

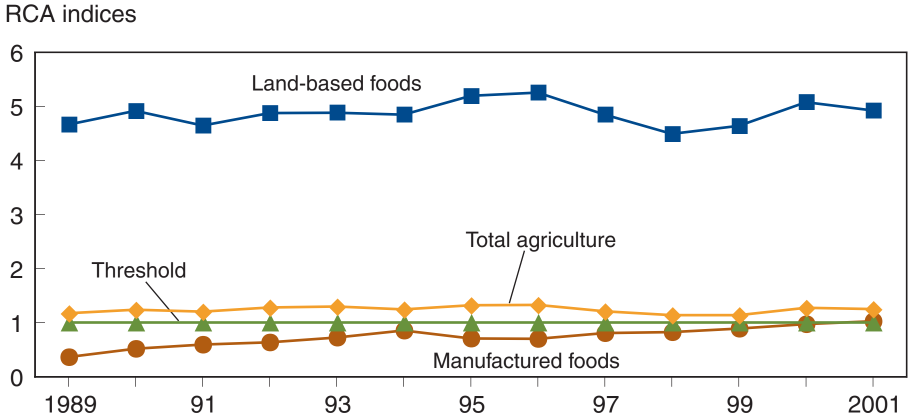
RCA indices have been used by applied economists as cardinal, ordinal, and/or dichotomous indicators of comparative advantage. As cardinal measures, they identify the extent to which a country has a comparative (dis)advantage in a particular product. As ordinal measures, RCAs rank products by degree of comparative advantage. They provide a binary-type demarcation between comparative advantage and comparative disadvantage as dichotomous indicators. Consistency tests have been developed to determine whether researchers can have confidence in the alternative interpretations of the index (Ballance et al., 1987). Recent test results suggest that RCAs are best viewed as ordinal and/or dichotomous indicators rather than as cardinal measures of comparative advantage (Ferto and Hubbard, 2003).

The advisability of using RCA as a proxy for actual comparative advantage depends on the problem being investigated and tradeoffs between the strengths and weaknesses of alternative empirical measures. The RCA is an imperfect measure of comparative advantage because it embodies not only the fundamental economic factors affecting relative efficiency, but also government policies and institutions that may distort markets. Alternative measures of comparative advantage are "domestic resource costs" (DRC) and "social cost-benefit ratios" (SCB), both of which compare the cost of domestic production with world prices (Masters and Winter-Nelson, 1995). Unfortunately, the data required to calculate these indicators are not readily available for many commodities. Calculation of DRCs and SCBs necessitate data on domestic prices, international prices, government subsidies, and taxes for the specific commodities being evaluated as well as the shadow price of foreign exchange. In addition, these indicators require information about the proportion of tradable and nontradable inputs used to produce one unit of each particular good. It is difficult, given these requirements, to assemble such detailed data for all but a few commodities in a limited number of countries.

DRCs or SCBs are often preferred indicators of comparative advantage when the focus of attention is restricted to a few commodities and/or trading areas. There are, however, circumstances when a case can be made for exploiting information readily available in the trade record to gauge comparative advantage, provided that it is also recognized that the "revealed" measures generated are likely to be imperfect measures of comparative advantage. Here, we use RCAs because of interest in providing a synoptic view of comparative advantage among many countries/regions and across various goods. We also use them because of the ease of calculation and the focus in this study on processed products and various foods subsectors where data needed to calculate DRCs and/or SCBs simply do not exist.

Figure 9

**The United States reveals a stronger comparative advantage in land-based foods than for total agriculture and a comparative disadvantage in manufactured foods**




Source: Derived from United Nations COMTRADE.

of the international mobility of inputs used in food production, which can lead to specialization within manufactured foods.

## *Bilateral Trade Complementarity*

Bilateral trade complementarity is measured using statistical correlations between the two components of Drysdale's commodity complementarity index, namely U.S. export specializations of traded commodities with corresponding partner import shares.[8] Export specializations measure the ability of one country to export a particular product compared with the rest of the world. Partner import shares measure the importance of a product import relative to all other imports. The correlation between these two measures indicates the extent to which the importing trade partner has a propensity to import products that the exporting partner has an advantage in supplying to the rest of the world. In this study, these indicators effectively link U.S. export advantages within the agricultural sector with relative importance of product imports by the partner country across the spectrum of land-based (fig. 10) and manufactured foods (fig. 11). The correlations help identify with whom it is advantageous for the United States to trade based on economic forces affecting U.S. supply and partner demand.

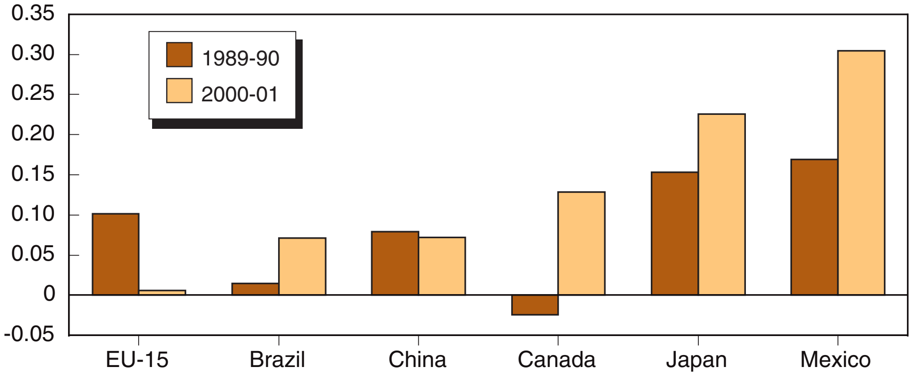
[8] The Drysdale index is unweighted. Attaching weights that account for the relative importance of the various products in domestic production would strengthen the index.

In land-based foods, the largest 2000-01 complementarities are for neighboring Mexico and Canada and resource-poor Japan. Interestingly, the coefficient for Canada turned positive after the first year of the Canada-U.S. Free Trade Agreement (CUSTA) in 1989. This switch, together with the post-1994 rise in the positive correlation coefficients for Mexico, suggests that the North American Free Trade Agreement(s), which enabled market forces to operate more freely, deepened U.S.-Canadian and U.S.-Mexican complementarity in land-based products. The relatively large and positive U.S.-Japanese correlations can be explained by the fact that Japan is land-resource poor and has to rely on other land-resource rich countries, such as the United States, to meet its demand for land-based food products.

Figure 10

**U.S. complementarities in land-based foods are greater for NAFTA countries and Japan**

Correlations, XSPus and MSj

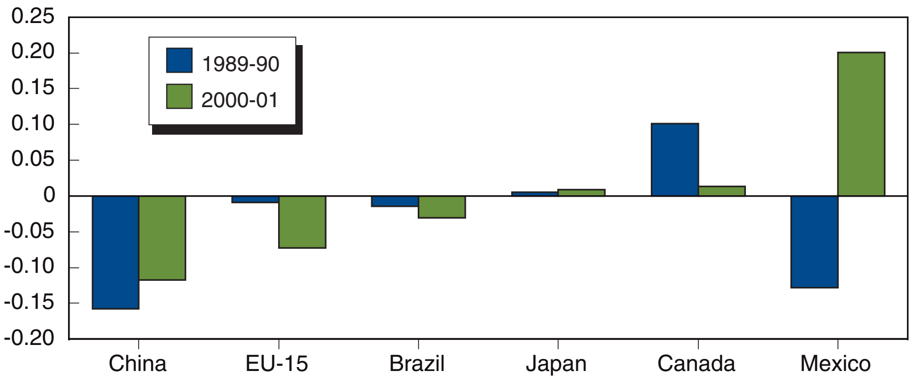



Source: Derived from United Nations COMTRADE.

Figure 11

**U.S. complementarities of manufactured food products are positive for neighboring NAFTA countries**

Correlations, XSPus and MSj




Source: Derived from United Nations COMTRADE.

Elsewhere, U.S.-partner complementarities in the land-based food subsector are mixed. U.S. complementarities with China have not materially changed during the last decade. However, U.S.-Brazilian complementarity deepened in the land-based subsector over time, due, in part, to increased Brazilian imports of wheat, a bulk commodity of which the United States possesses a strong comparative advantage.[9]

Policy interventions have affected the nature of bilateral trade and partner complementarity. The decline in U.S.-EU complementarities between 1989-90 and 2000-01 reflects the fact that the EU is becoming less important as a market for land-based foods. This decline is due, in part, to increases in the use of domestically produced grains as feed in the EU, the direct result of EU-92 reforms. These reforms redressed EU internal price differentials between soybeans and grains by lowering domestic prices for feed wheat and barley. In addition, concerns about genetically modified organisms

[9] Argentina supplies Brazil with most of its wheat and wheat-based products because of logistical advantages and phytosanitary restrictions imposed by Brazil on U.S. commodities. However, this does not detract from the economic relationship characterizing U.S. and Brazilian trade in the land-based sector (as defined in the methodology used in this analysis) given fungibility of commodity trade in the world market.

curtailed EU imports of soybean products, commodities in which the United States possesses comparative advantages.

The profile of U.S.-partner complementarities for manufactured foods is different than that for land-based foods. The correlations are generally negative—an inverse relationship exists between U.S. export specializations for the various food products in the manufactured food subsector and corresponding partner import compositional shares for these products. This relationship reflects the relative export disadvantage for many U.S. manufactured foods for which partners have comparatively large import shares. Negative correlations do not mean that societal payoffs from increased U.S. exports of manufactured foods are not realized, for there are likely to be profitable niches within each foreign market for differentiated products.

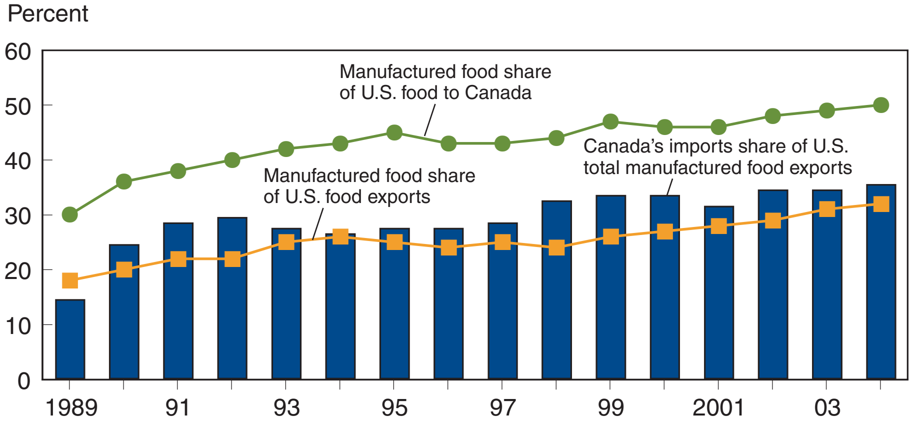
U.S.-Mexican complementarities in manufactured foods shifted from being negative in 1989-90 to being strongly positive in 2000-01, suggesting that NAFTA freed up cross-border trade in processed products by removing tariffs and other trade barriers and allowing market forces to operate more efficiently. In contrast, U.S.-Canadian complementarities fell between 1989-90 and 2000-01. In addition to the 1989 CUSTA, the expansion of two-way, or intra-industry, trade in manufactured foods between the United States and Canada, whereby similar products are simultaneously imported and exported by both partners, contributed to changes in U.S.-Canadian complementarities. The expansion of two-way trade in manufactured foods reduces complementarity whenever trade in virtually identical products occurs (app. D). Moreover, much of the measured Canadian-U.S. intra-industry food trade is more apparent than real, given the aggregation of international trade data. Not having sufficiently detailed trade data at the individual, product level for semi-processed products (like prepared flour mixes and dough) as well as for differentiated consumer foods (such as branded beverages, breakfast cereals, and confectionary products) limits our ability to accurately measure complementarity in manufactured foods using the Drysdale framework.

NAFTA partners have accounted for an increasingly larger share of U.S. agricultural exports, in part, because of efficient transportation linkages. Due to differences in national endowments, Mexico is consuming a larger share of U.S. exports of land-based processed food, such as livestock and oilseed products. By contrast, Canada is the largest market for U.S. manufactured foods. Moreover, Canada's import share of U.S. manufactured food exports is increasing (fig. 12). U.S. food exports are increasingly shifting toward manufactured foods, as reflected in the RCA, with Canada's share having reached 50 percent in 2004. Countries with relatively high incomes and similar resources, like the United States and Canada, typically engage in intra-industry food trade (Henderson et al., 1998).

Empirical evidence in this report shows that specialization patterns in food trade are relatively stable for land-based products. This finding is consistent with the resource-endowment explanation of specialization and trade. Less well understood are changes taking place for food products that can be produced most anywhere capital and technology are available. The growth of intra-industry trade makes trade patterns for manufactured food products less stable and less predictable than for land-based products. Exporters with a highly diversified product portfolio, such as the United States, are bound to

Figure 12

**Canada is becoming a more important market for U.S. manufactured food products**




Source: Derived from United Nations COMTRADE.

see changes in the composition of their food exports over time. It would be misleading to state that the United States is losing its comparative advantage in high-value foods based on trends or shifts in the overall U.S. trade balance or the composition of its food trade. The United States has a comparative advantage for high-value food products that are dependent on the U.S. natural resource base. The United States also has the potential, as do other countries, to develop comparative advantages in products less dependent on this natural resource base. The United States has opportunities to cultivate comparative advantages in manufactured food, given improved access to the enlarged North American market due to NAFTA.