CHAPTER 11

From Local to Global: International Trade and Value Chains

11.1 How Trade and Policies Link Local Markets to Global Food Systems

11.1.1 Motivation and Guiding Questions

This section expands our modeling toolkit to address interactions between markets in a global food system. In recent decades, a wave of globalization, driven by lower transport costs and openness to trade, has led to greater interconnection between countries. What explains the direction and quantity of trade flows that we observe, and the international prices at which trade occurs?

On average over time, countries can use their comparative advantage to earn gains from trade, but doing so alters income distribution and price volatility in systematic ways that can drive similar policy responses around the world. Losses drive more political engagement than gains, and concentrated impacts are especially important in driving the formation of politically active interest groups. How do governments respond to these pressures, taking account of both agricultural trade and domestic policies? Can we track how farm policies affect both producers and consumers?

International trade can help stabilize local markets by diversifying food sources, and also raise a country's vulnerability to world price spikes. In this section we address where, when and how trade can play a stabilizing role that improves a country's food security, and when do governments restrict trade in an effort to limit transmission of international price spikes to their own domestic consumers, in the context of trade regional and global agreements that governments use in response to political pressure and economic opportunities in their own agriculture and food markets.

By the end of this section, you will be able to:

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1. Use supply, demand and trade diagrams to explain, predict and evaluate changes in quantities produced, consumed, imported and exported;
2. Use information about transport costs to quantify what people at one location would pay if they imported and would receive if they exported a product to or from the rest of the world, and describe how that price band limits the range of fluctuation at that location;
3. Use available data to describe changes in the volume of total merchandise trade, agricultural and food trade around the world; and
4. Use available data to describe changes in trade restrictions around the world, in terms of their effects on farm revenue and prices paid for food commodities within countries.

11.1.2 Analytical Tools

The analytical diagrams used so far in this book refer to either an individual person or a local market. Those diagrams revealed how individuals, communities and whole countries can take advantage of their differences to exchange things with each other, seizing their comparative advantage to earn gains from trade.

We first defined and used the concept of comparative advantage in Chapter 4 on social welfare, using Fig. 4.10 and other diagrams to show how a person or community is affected by trading with others. The level of each person or community's wellbeing depends on the absolute level of their productivity and resource endowments, but trade with others depends on differences in productivity. Each diagram until now focused on just one person or one market relative to a given price in trade. To see where that trade price comes from, we need to expand our diagram to see supply-demand balances in that market relative to the entire rest of the world.

Comparative Advantage, International Prices and Global Supply–Demand Balances

In all previous market diagrams, the possibility of trade with others was drawn as a horizontal line at the price offered for purchase or sale to people elsewhere. The quantities exported or imported did not affect the price in trade, on the grounds that the rest of the world is typically so large that changes in the one market of interest could not affect its supply-demand balance. Drawing each market as if it were an infinitely small share of the whole world, and therefore a 'price taker' with no influence on the rest of the world's prices, made the analysis simpler and clearer without affecting our results.

Previous chapters focused on just one community or country, and we could see the effects of their government policies on their population using a fixed international price. To see how each country's market connects to other countries, we need a more complicated diagram as drawn in Fig. 11.1.

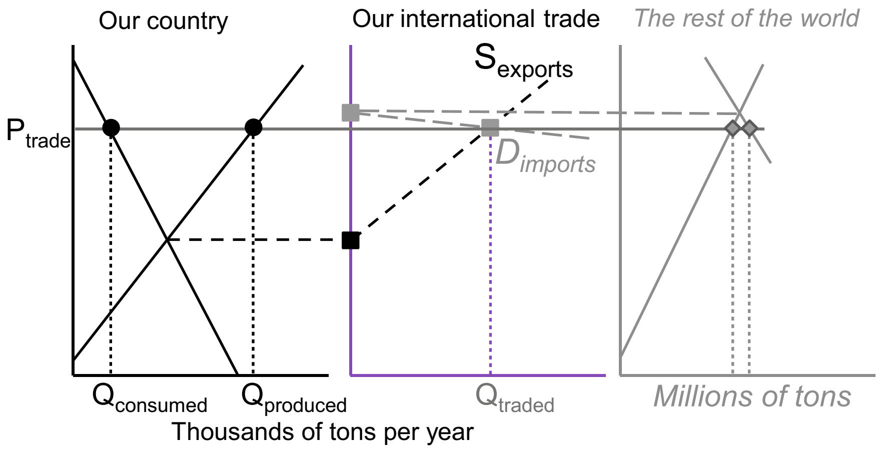

Fig. 11.1 Trade prices and comparative advantage in a three-panel diagram

The model of international in Fig. 11.1 is known as a three-panel diagram. It shows the entire world market for a particular product, such durum wheat or yellow corn, divided into producers and consumers in our country of interest on the left, and the entire rest of the world's producers and consumers on the right. The middle diagram shows the possibility of trade between our country and the rest of the world. The vertical axes of all three panels are aligned in the same currency, for example U.S. dollars per ton, but the horizontal axes differ. The rest of the world is likely to be a large place, with quantities measured for example in millions of tons, while our country of interest is likely to be smaller, for example with quantities measured in thousands of tons.

In our country on the left there would be a price in autarky at which we would trade nothing, corresponding to the lower square on the vertical axis of the international trade diagram. If others were willing to pay a price above that, our country would supply a quantity of exports that is equal to the gap between our country's production and consumption at that price. The dashed supply of exports line whose slope is flatter than our producers' supply curve, because it also takes account of our consumers' demand curve. Our country's elasticity of supply for exports is the sum of our own population's supply and demand elasticities.

Similarly for the rest of the world on the right there is a price at which it would not import anything, corresponding to the upper square on the vertical axis of the trade diagram. At any price below that, the rest of the world would import the gap between its production and consumption. Because the world is a big place, measured for example in millions of tons, that would be a large quantity of imports when measured in thousands of tons. That is why the whole world's demand for imports from our country is very elastic with respect to price, and could be drawn as an infinitely elastic horizontal line in earlier diagrams.

If we redrew this three-panel diagram by dividing the world into two equal-sized regions, each area's demand for imports from the other might have about the same price elasticity as the other region's supply of exports. Similarly we could redraw this diagram for our country when it is importing from a large rest of the world, and the price we pay in trade set by their highly elastic supply of exports.

Each country's comparative advantage for each product depends only on how its supply-demand balance compares to the rest of the world. A country whose domestic price is lower than prices elsewhere will have producers who can and would export, raising their country's price along their supply of exports curve until it meets the rest of the world's demand for imports at the international trade price. Similarly, a country whose price is higher than elsewhere will have consumers who would want to import, so allowing free trade would lead to imports and a decline in the domestic price to its level in international trade.

The three-panel diagram in Fig. 11.1 shows the market for just one product, but our country's comparative advantage in this market originates in our population's decisions about whether to produce this thing instead of other goods and services. The supply curve for this thing in our country is upward sloping because increased production draws resources that would otherwise be employed producing other things. A higher price in trade that leads to increased production for export in this market would cause supply curves for other things to shift left and down, reducing the country's comparative advantage in those markets and bringing in imports of those things. By definition, each country has a comparative advantage in exporting the things for which its supply and demand makes that product relatively abundant within the country, compared to other things which are relatively scarce so the country has a comparative disadvantage in production and an interest in importing.

Each country's overall trade balance, adding up all their imports and all their exports, is determined by the macroeconomic forces that alter the country's exchange rate as discussed in Chapter 9. For example if our country's currency is the peso, and foreigners start buying pesos for investments in our country, their use of dollars to purchase pesos will bid up the dollar-to-pesos exchange rate which lowers the price in pesos for all traded products, reducing exports of everything exported while increasing imports of everything imported. That change would need to be just sufficient to use the additional dollars that foreigners want exchange for pesos to pay for investments. Conversely, if foreigners pull their money out, the exchange rate would devalue and peso prices of traded products would rise, reflecting that the population of our country is now less wealthy and so imports less and ships more things to others.

As discussed in Section 9.1 of the chapter on macroeconomics, our country's monetary policy and the supply of pesos is managed by the central bank, while fiscal policies influence how many pesos or dollars the government wants to borrow or lend. All of those factors would influence the exchange rate, and hence the total volume of imports and imports, by attracting or discouraging a flow of foreign exchange into the country. When a country is attracting an inflow of foreign currency for capital investment, its balance of trade shifts towards more imports and less exports, but it is still the degree of comparative advantage for each product that determines which things are exported and which are imported.

The three-panel diagram in Fig. 11.1 is drawn for simplicity with a single price received by exporters and paid by exporters, for example in U.S. dollars. An important next consideration is the role of transaction costs, as shown in Fig. 11.2.

Business transactions often involve specialized jargon that is useful to learn. For international trade, as shown in Fig. 11.2, export prices are denoted as P_{fob}, meaning a free-on-board price which indicates that the good is available for shipment to any destination. The product is free of obligation to pay any taxes or other costs, and is on board a means of transport for outbound shipment. There would then be some transaction costs from that point onwards to the importer whose price is denoted P_{cif}, meaning that someone has paid the cost of the good itself, the insurance for loss in transit, and all freight costs for the transportation itself.

Every importer's P_{cif} is greater than every exporter's P_{fob}, by an amount equal or less than the transaction costs between them. If there were an importer-exporter pair for whom the P_{cif}–P_{fob} gap was larger than transactions costs, traders looking for opportunities would buy from the exporter and ship to the importer. There are many such traders around the world, looking for moments when the price at the origin of potential exports is low enough to justify transport, relative to the price at the destination of potential imports. These traders will then bid for space on transport vessels and all of the other services needed to complete the transaction.

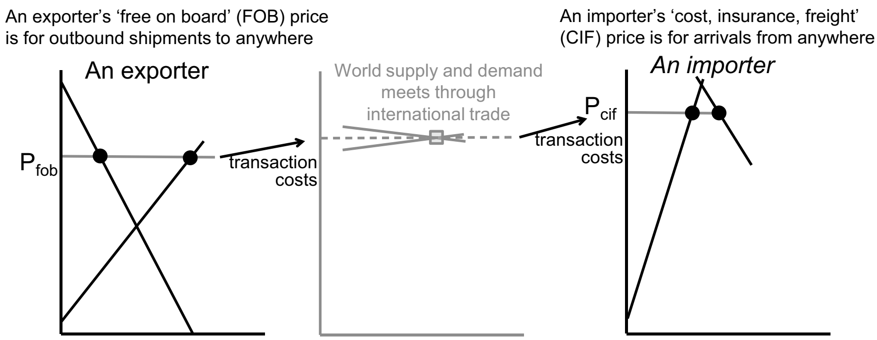

Fig. 11.2 Transactions costs make exporters' price received lower than importers' price paid

In world trade there are flows of everything to and from everywhere, with day-to-day adjustments in planned shipments based on news about changes in likely harvests or unexpected events in an origin or destination country. Most of the volume travels on a few routes, as traders look for the origins and destinations that would make the journey profitable. The lowest transport cost per mile is for ocean trade between deepwater ports on 'max'-size ships that carry over 50,000 tons of bulk grain. The vehicles move slowly but use little fuel per ton carried and each mile traveled. Loading or unloading between large ships and smaller boats, trains or trucks can be expensive and subject to congestion at port or other transit facilities. Each shipment may be loaded and unloaded multiple times, adding to its cost and delays.

The cost per mile of transporting each shipment is sharply lower on larger vehicles or vessels, so transaction costs depend on infrastructure and technology. For example, grain exported from inland farms in the U.S. is often shipped by truck to trains or barges that travel south down the Mississippi river to ports in the Gulf of Mexico. Grain may also be shipped by truck to trains to ports in the west and east. The USDA monitors and publishes transport costs on each route, partly to inform producers and end-users, but primarily to monitor conditions and address policy concerns about public investment and regulation of the transport sector that influences prices received by farmers and paid by end-users in each region of the U.S.

Illustrative examples of transportation costs for bulk grains shipped through the southern route to Latin America, Africa and Asia are in Table 11.1.

The U.S. data shown in Table 11.1 reveal how costs per unit of distance vary by a factor of 100, for similar products from U.S. farms to a deepwater port overseas. Local costs at either end of these journeys will differ, and are particularly high where conditions require smaller vehicles that use more fuel and labor or other resources per ton carried, including final shipments to end users. Handling loose bags or boxes can also be costly, leading to cost reductions when those are placed in standard-size containers for multimodal transfer from truck to rail to boat.

The specific time period for which these costs were observed is from January through March 2022, with forward quotes for ocean shipments a few months later. This was a period of high U.S. transport costs, due to congestion at transit points caused by rapid recovery of demand for traded goods after the COVID recession. Transport costs can also vary due to changes in the cost of fuel, labor, equipment and facilities at each location. Observing cost differentials within the U.S. for the same product at the same time to different destinations shows how the main differences are between roads, rail and water. Each step in efficiency of resource use can involve a 10× difference in cost, for up to a 100× difference in bulk grain transport costs.

Cost differentials among ocean routes are smaller than differentials between road, rail and water shipment, but the examples shown reveal systematic patterns that influence global food trade. Shipments to Central America via Honduras use smaller ships for a shorter distance and were about 7× more

Table 11.1 Transportation costs for bulk grain from the U.S. to overseas, January–March 2022

	Cost per shipment	*Distance*	*Cost per kilometer (ones or thousands)*	
	US$/mt	*km*	*US$/mt*	*'000s*
Road				
Short distance (25 miles)	$13.04	40	$0.33	$326
Middle distance (100 miles)	$39.19	161	$0.24	$243
Longer distance (200 miles)	$74.79	322	$0.23	$232
Rail				
Wichita, Kansas to U.S. Gulf (New Orleans)	$42.70	1090	$0.039	$39
River barge				
St. Louis, Missouri to U.S. Gulf (New Orleans)	$17.05	1207	$0.014	$14
Ocean shipping				
U.S. Gulf to Honduras, February 2022 (7820 mt)	$57.15	2104	$0.0272	$27
U.S. Gulf to Djibouti, March 2022 (10,000 mt)	$209.97	16,748	$0.0125	$13
U.S. Gulf to Sudan, March 2022 (35,700 mt)	$149.97	15,438	$0.0097	$10
U.S. Gulf to Sudan, February 2022 (35,780 mt)	$77.60	15,438	$0.0050	$5
U.S. Gulf to Japan, May 2022 (50,000 mt)	$78.90	20,000	$0.0039	$4

Source: Authors' calculations from USDA data. Trucking costs are from USDA Agricultural Marketing Service, Grain Truck and Ocean Rate Advisory (April 2022). Barge, rail and ocean shipping costs are from the USDA Agricultural Marketing Service, Grain Transportation Report (March 3, 2022). Trucking costs are averages for shipments of 25 mt (55,000 lbs) based on legal limit on U.S. highways, and rail and barge costs are averages, and ocean shipping costs are five of the 13 illustrative examples provided by the USDA in the Grain Transportation Report for March 3, 2022. More recent editions of these reports are at https://www.ams.usda.gov/services/transportation-analysis/GTOR and www.ams.usda.gov/GTR

costly per ton-kilometer than shipments to Japan, and twice as costly per ton-kilometer than the longer distance through the Suez Canal to the East African port of Djibouti which serves Ethiopia among other destinations. Using larger ships on that same route to Sudan is somewhat less expensive per ton, and two different shipments to Sudan of similar size differ in cost due to the Jones Act requirement that half of U.S. food aid be shipped on U.S. flag vessels. The Jones Act also requires that all commercial ocean shipments within the country be on U.S. flag vessels, which significantly raises the cost of food and all goods transported from the mainland to Puerto Rico and Hawaii among other destinations.

The data in Table 11.1 refer to outbound shipments from inland North America to Central America, Asia and Africa, and similar patterns would apply for onward transport inland within each continent, including Europe and South Asia. At each location there is a potential FOB price for outbound shipments and a potential CIF price for inbound deliveries. Where transport is feasible and free trade is allowed, this CIF-FOB band provides upper and lower bounds on prices at each inland location. Traders are looking for any potentially profitable price differences, bidding up prices where they are low and selling where prices are high, thereby ensuring that prices at each place are kept within bounds defined by transport costs. The result is a spatial *price surface* with higher prices at inland destinations towards which the product is flowing, leading up to spatial peaks at the places buying the product into which transport is most expensive. Conversely, the lowest prices are found at the most remote places from which the product is exported. The price surface is flattest between deepwater ports on the ocean, due to the relatively low cost per ton of shipping in large boats.

The Interaction of Storage and Trade

People respond to forecasts. Information suggesting that prices will rise in the future will lead people to buy or hold on to commodities, and traders will ship things towards the places where prices are expected to rise the most. Conversely, indications of a future price decline will lead people to sell before that happens, and prompt traders to ship grain out of that location. Some traders specialize only in transport, while others also own physical storage facilities so they can actively manage their own inventory. Stocks may also be held on farms after harvest and held by processors and distributors for varying periods of time before onward sale. A minimal level of 'pipeline' stocks is held by actors all along the value chain to maintain continuity of operations, and those enterprises will use operational facilities for storage if they believe prices will rise in the future, and then draw those down to the minimum needed for operational necessity if they believe prices will fall.

Many agricultural commodities are harvested almost simultaneously by different farmers in a given region, leading to a price decline over the few weeks or months after harvest. Even if physical storage could be done over more than one year, the anticipated arrival of each season's new crop typically leads actors in the value chain to draw down any stocks they might hold in advance of the price decline. They seek to avoid holding on to a product that could be bought later at a lower price, and therefore aim to have their storage facilities almost empty in time for the new harvest when prices will be lowest.

The month-to-month price rise after each harvest reflects the cost of storage, which differs greatly among actors in the food system. In low-income countries, farmers who grow basic commodities are often among the poorest people in society. They have urgent needs and high opportunity costs of holding on to whatever they have harvested, with limited access to any credit or insurance, so they typically sell immediately and use the proceeds to invest in school fees and health care, or to finance their seasonal migration and nonfarm activities for the offseason after harvest. If they did have access to loans in the past they may also have borrowed against the harvest and need to pay that back immediately. In contrast, many commodity growers in the U.S. and other high-income countries have access to credit at very low interest rates, and also have savings of their own, so they often invest in on-farm storage facilities that allow them to store their harvest for as long as they think will be profitable.

The actors along each value chain who hold the most stocks are those with the highest expected returns and lowest costs of storage, including both the operational expense of protecting commodities against damage or loss, and also the opportunity cost of keeping a valuable asset locked up in a bin or silo. Protecting commodities against insects and mold or other organisms is often more difficult in tropical places especially when there is high humidity in the postharvest months, and easier in temperate climates where temperatures and moisture levels usually fall after harvest. In high-income settings, where owners of stored products can borrow or lend funds as needed, the monthly cost of storage and hence expected price rise needed to justify holding stocks is mainly the prevailing interest rate on loans. In low-income countries, that monthly cost is often much higher, leading to a steeper expected price rise needed to justify holding on to stocks from one harvest to the next, and therefore a larger price decline immediately after harvest.

The actual trajectory of prices at any given location is subject to a continuous flow of news about likely future supply and demand, so prices bounce around randomly as people adjust their stockholding and trading behavior. To see the underlying pattern we must hold some things constant and conduct a highly simplified thought experiment, as in the stylized trajectory of prices shown in Fig. 11.3.

The model of price dynamics from which Fig. 11.3 is drawn reflects the market for a storable product like wheat at an inland location that sometimes has big harvests that exceed local demand and lead to exports, but more often has small harvests that lead to imports. Locations like this include many dryland regions of East, West and Southern Africa, so for example this could be the price of wheat in Addis Ababa, the capital of Ethiopia, where the wheat harvest usually starts in October. The diagram is intended to show the predictable equilibrium result of interaction between private storage and trade that would occur without government intervention. In reality, many governments (including Ethiopia's) buy and sell commodities or restrict trade in ways that make the picture less predictable.

The three harvests over the time period shown happen to be small, then big and then small again, leading to imports, exports and then imports, at prices indicated by the fluctuating dark line. The upper and lower light-colored lines are drawn based on actual historical price fluctuations of internationally traded wheat, for which Ethiopia's nearest ocean port is Djibouti. The upper line would be the cost of importing wheat from the world, and the lower line would be the price received when exporting wheat to the world, in both cases

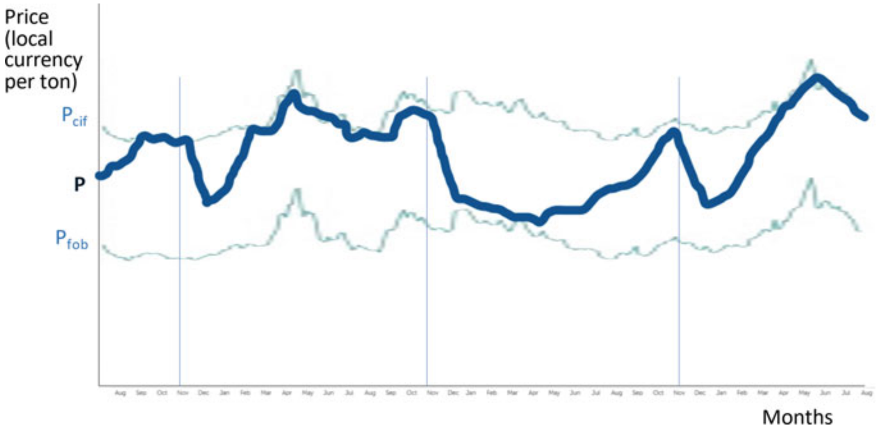

Fig. 11.3 Harvests and storage drive fluctuation in price within bounds set by trade prices *Source*: Authors' sketch of a hypothetical trajectory of prices over three years, with the arrival of harvests at the vertical guidelines. The light-colored upper line shows the hypothetical the landed cost of any imports [P_{cif}] and the lower line is the price that would be received for exports [P_{fob}], from ocean ports where the trajectory of prices is a three-year sample of the actual history of wheat prices available from the IMF. Actual prices for other commodities and time periods are at https://data.imf.org/?sk=90c0ef21-5c6f-4d2f-a99a-2dbcbfaca509&hide_uv=1

via Djibouti. For clarity in this scenario, we can imagine that transport costs to and from Djibouti remain constant throughout the period, although in reality they would vary with the cost of fuel and other inputs.

The dark line shows the actual price observed, which begins the period shown rising at the monthly cost of storage from the previous harvest. Traders have observed that price trajectory, and expect local stocks to run out around September so they would have ordered imports to arrive before that in sufficient quantities to last until the new harvest arrives in November. That harvest turns out to be small, so traders again place orders for imports. If they expect that the harvest will provide roughly four months of expected consumption, they will place sufficient orders for the eight months from March through the next harvest in November. That harvest turns out to be big, well larger than consumption needs, so prices fall to the cost of exporting. In this scenario the period of exporting lasts from January through April, because shipments cannot all occur simultaneously, but once traders have exported the difference between harvest and expected consumption for the year they will stop exporting, and prices will start to rise again at the cost of storage to their peak just before the next harvest. That harvest then turns out to be small, so traders again place orders for delivery by the time they expect imports will be needed, at which point the cost of importing dictates the price.

This stylized picture shows how a country that oscillates between exporting and importing might have prices that fluctuate within the CIF-FOB band.

That range of fluctuation would be wider in places with worse infrastructure or are farther from ocean ports, and widest of all if trade were completely impossible. In the absence of trade, prices would rise even higher after each small harvest, and would fall even lower after each big harvest. In countries that rely on uncertain rainfall such as wheat and other dryland grain producers, access to international markets not only yields gains from trade but also plays a stabilizing role. In these settings, the price-stabilizing role of trade can be seen as using the world market as a form of storage, selling into that market after large harvests when prices would otherwise have fallen even more, and buying from the market after small harvests when prices would otherwise have risen even more. Places where their own production is more consistent from year to year, or where their own storage cost is low, would benefit less from that stabilizing effect of being open to imports or exports. They would still have gains from trade in response to comparative advantage, but those would come at the cost of experiencing the instability of the whole world's supply-demand balance. Countries with very stable production of their own would not need or get the stabilizing effect of trade shown in Fig. 11.3.

Agricultural Trade and Globalization

Changes in the cost and benefits of international trade, relative to domestic activities, cause waves of globalization in the world economy. The most recent period of increased international trade occurred from the mid-1980s to the late 2000s. That boom in trade occurred mostly in the nonfood sector, but had important consequences for agriculture and food systems.

A major factor in the rise of trade was adoption of standardized shipping containers. These allowed cargo to be loaded and carried by truck, trains and ships without having to handle loose cargo, and could be locked and sealed or open the container in transit. Using multimodal containers of uniform size could sharply lower handling costs and reduce delays in transit, but depended on coordinated investment in new equipment and infrastructure. The sizes used today were agreed upon through the International Organization for Standardization (ISO) in 1968, after which new ships and port facilities as well as train and road transit were built around those standards, driving a sustained decline in transport costs for containerized freight.

Another big factor driving globalization was economic reform in China starting in 1981, enabling that vast country to rise from extreme poverty and industrialize quickly as the world's largest provider of manufactured goods. Other countries in East and Southeast Asia also experienced rapid economic growth and industrialization at that time. The previously industrialized, mostly service economies in North America, Europe and elsewhere generally welcomed the increased trade with China and other countries, despite the resulting displacement of their own manufacturing sector, and they undertook their own policy changes towards more openness to international trade.

A third driver of the 1980s–2000s globalization wave was the rise of computing and the internet, which fueled growth within each country, facilitated trade in physical goods, and also brought opportunities for trade in services. Services account for about two-thirds of the entire global economy, complementing the large agriculture and food sector in low-income countries, and also the industrial sector in middle- and higher-income countries. Some international trade in services involves people traveling, such as engineering firms whose staff live in one country but conduct site visits for projects elsewhere, and some occurs online such as customer service call centers.

The drivers and composition of increased trade in the 1980s–2000s mainly involved manufacturing and services, but globalization also affected agriculture and the food sector. The dietary transition to more animal foods and vegetable oils in Asia was made possible by rising imports, mostly bulk shipments of feed grains from North and South America, and also some containerized imports of food products including meat, dairy and some vegetables, facilitated by the rise of refrigerated containers known as reefers. International trade in services also contributed to worldwide food system transformation in branded foods, for both grocery stores and the restaurant sector. The creation of multinational brands typically involves some foreign direct investment, where a company operates its own facilities in multiple countries, but also licensing, franchise operations and joint ventures. Globalization of food services can spread even in the absence of physical trade, allowing the same brand names to appear in grocery stores and restaurant names all around the world even in very remote places.

Focusing on trade in physical merchandise and agricultural products, the total value of shipments from 1980 through 2022 is shown in Fig. 11.4.

Panel A of Fig. 11.4 shows trade volumes in value terms at 2017 prices, as dollars per person each year to adjust for global population growth. Values on the left axis show food and nonfood agricultural products, and on the right axis show all merchandise trade, both as the sum of all imports plus exports shipped between countries around the world. Levels and changes on the left axis are all exactly one-tenth those on the left axis.

In 1980 at the start of the period shown, total trade in food products (mostly bulk agricultural commodities) was worth around $150 per year per person on the planet, while nonfood agricultural products (mainly cotton and fiber, lumber and pulp, rubber and hides) accounted for another $50 per person, while the total for all merchandise trade was just under $1500. From 1980 to 1985 all of those values declined sharply, down to about $100 in food and $1000 in total merchandise trade. The early 1980s downturn was part of a deep recession in the U.S. and other countries, triggered by higher interest rates designed to stop rising inflation that had accelerated in the 1970s. From 1985 to 2022, total merchandise trade grew sharply in a stepwise manner, first a recovery from 1985 to 1990, then some growth from 1993 to 1995,

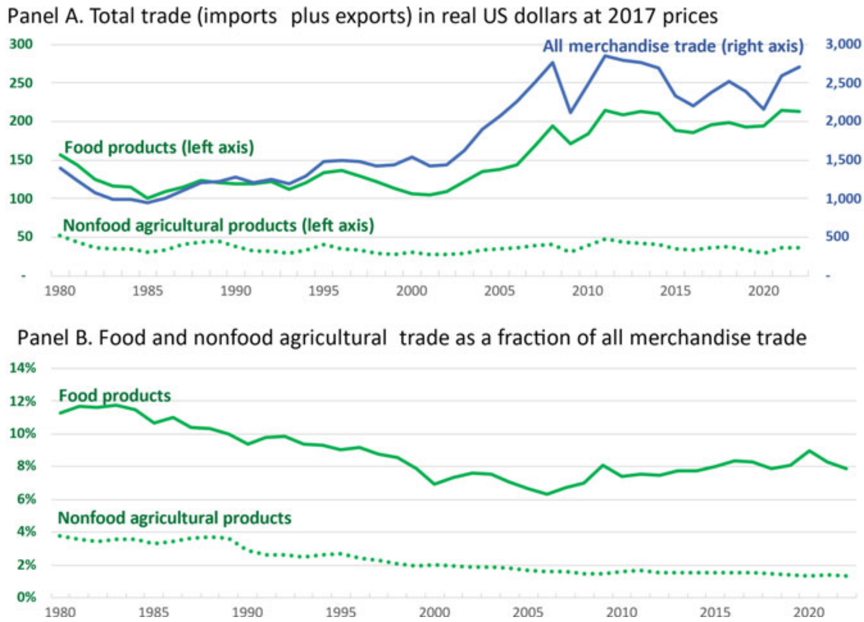

Fig. 11.4 Food and nonfood agricultural trade during the 1980s–2000s wave of globalization *Source*: Authors' chart of data from the World Trade Organization [WTO]. Original data are totals in current [nominal] US dollars, converted to trade per person using global population in terms of real U.S. dollars at 2017 prices using the CPI here: https://fred.stlouisfed.org/graph/?g=1axBm. These and related data on global trade are available from WTO Statistics here: https://stats.wto.org/?idSavedQuery=5601e036-62ef-423b-8735-981338215bf9

followed by rapid growth from 2002 to 2008. There was then another downturn in 2009, again part of a deep recession in the U.S. and recovery from that but no further growth in total trade up to the most recent data in 2022.

Panel B of Fig. 11.4 shows trade in food and other agricultural products as percentages of the total. From 1980 to 1983 those shares stayed roughly constant, but then for more than 20 years trade in nonfarm products grew faster than trade in food or other agricultural products. Food's share of global trade fell almost in half, from just under 12% in 1983 to just over 6% in 2006. The share of trade that was nonfood agricultural products fell even more, from 3.6% in 1984 to 1.6% in 2006. Since then food trade has grown faster than trade in other merchandise, so its share of the total has risen to 8%, briefly reaching 9% at the start of the pandemic in 2020. Returning to Panel A we see that the value of agricultural trade is actually more stable than all merchandise trade in this period, with smaller declines during downturns.

The wave of globalization, measured here as the real value of merchandise trade per person, consisted mostly of nonfood trade which almost tripled from $1000 in 1985 to $2800 in 2008. The quantity of food traded did not have sustained growth for the first 15 years of this period, as its value in 2000 was about the same as in 1985, but then from 2000 to 2008 the real value of global food trade doubled from $107 to $214 per person and remained at $213 in 2022.

Agricultural Policy, Trade Agreements and the Political Economy of Protection

One reason for the later and smaller increase in food trade compared to other merchandise could be greater policy restrictions on trade in agriculture than in manufacturing. As we have seen, in any one country's markets, restricting imports generally imposes a small cost on each of the many consumers, while providing concentrated gains to a few producers. Each existing producer is well aware of what they gain from import tariffs or quotas, and will invest time and money in persuading the public and government officials that imports should be restricted. Those producers already have a working enterprise. They know what they would lose if more imports were allowed, and those potential losses are visible to everyone. In contrast, each consumer is unlikely to know that import restrictions raise retail prices, and even if they did, their potential gains from increased imports are in the form of lower prices and savings they would spend on many different things, so each person who would benefit has little at stake and is likely to remain inattentive to trade policy.

Political leaders in all kinds of countries face similar pressures. Many political leaders don't know or don't care that restricting imports harms their society as a whole, so they ally themselves with incumbent producers and agree to help them at the expense of others in their country. That dynamic leads governments to impose high barriers on their own populations, protecting whichever set of producers has the most political influence. But occasional reformers realize that coalitions of people in their country who would benefit from more open trade can be organized to pursue legislation that reduces those trade barriers and thereby improves the country's standard of living. When one country does that, other countries can export to them, creating the possibility of international agreements between reform-minded government leaders.

The world as a whole has no global government, but governments can sign treaties with each other and create jointly owned international organizations. Much of the modern landscape of international agreements was formed to manage recovery from World War II. The United Nations was created in 1945, and its various specialized agencies provide technical services and programs in collaboration with their counterparts in each country's government. Two of the biggest such agencies are the World Bank and the International Monetary Fund (IMF), created to provide some of the services that an individual country's central bank could do. In the 1940s, proposals to form a global 'International Trade Organization' alongside the IMF were rejected in favor of a simpler international treaty, ultimately signed in 1947 by just 23 countries as the General Agreement on Tariffs and Trade (GATT).

From 1947 to 1994, eight successive rounds of international negotiations through the GATT allowed governments interested in reducing trade barriers to agree on which tariffs and quotas would be reduced, by how much and over what time frame. A total of eight negotiating rounds each led to a revised treaty, that could then be signed by additional governments if they wished. Countries could always withdraw from the treaty, or raise tariffs and quotas in violation of the treaty, with the only enforcement mechanism being the GATT's own dispute resolution committees that allow member countries to impose their own retaliatory trade restrictions. Successive rounds created ever-greater incentives for more countries to join the treaty and follow its rules, deepening each other's commitments to keeping trade barriers as low as possible.

Agricultural trade was omitted entirely from the initial rounds of GATT negotiations, as too politically sensitive and unpredictable for governments to willingly be bound by a global treaty. Individual pairs or groups of countries would sign bilateral and regional treaties, of which the largest and oldest is the Common Agricultural Policy (CAP) among European countries launched in 1962. The CAP allows entirely free trade among the members, behind a common external tariff, with pooled funding for programs to assist farmers and shared regulations about environmental, food safety and nutritional aspects of the food system. Other regional agreements use varying degrees of integration and policy harmonization, such as the MERCOSUR agreement among South American countries launched in 1991, or the COMESA agreement among East and Southern African countries and NAFTA between the U.S., Canada and Mexico both signed in 1993.

The first global agreement on agricultural trade policy was reached in 1994, through the eighth round of GATT negotiations. Treaties are commonly named after the place where they are signed, in this case regarding the initial agreement on the scope and objectives of negotiations that were set at a meeting in Punta del Este, Uruguay in 1986. Previous global agreements had reduced non-agricultural tariffs and quotas so much that there was little further cutting to do, so the Uruguay Round focused on agriculture and cotton textiles as well as trade in services, foreign investment and intellectual property protection. Those topics proved to be so difficult that reaching agreement took almost a decade.

The conclusion of the Uruguay Round created a framework for trade policy that reflected and accelerated the push towards globalization of the late 1980s and 1990s. The secretariat in Geneva that implements the treaty was renamed the World Trade Organization (WTO), with an expanded mandate including the Uruguay Round Agreement on Agriculture. By design, the agricultural agreement specified only modest and gradual reductions to barriers already in place. Its primary goal was to establish categories of government intervention to be measured and compared, with limits on the degree to which new barriers could be introduced in the future. Those provisions, as well as farm trade aspects of regional agreements like MERCOSUR, COMESA and NAFTA, helped facilitate the increased trade observed through the 2000s.

In 2001, China joined the WTO and the organization launched its ninth round in Doha, the capital city of Qatar, with a mandate for negotiators to find areas of agreement that would be more favorable for low-income countries. As of late 2023 this Doha Development Round remains ongoing, with periodic meetings but little prospect of a new global treaty beyond what the GATT and WTO had already achieved. The largest benefits from trade agreements come from reducing the highest barriers, since those markets offer the most gains from additional trade, and the Doha round's development agenda called for negotiations on policy changes which economists estimate would generate much smaller and more uncertain gains than earlier rounds. Governments' willingness and ability to make agreements also depends on whether they expect each other to be increasingly valuable trading partners over time.

When global trade growth stalled after 2008, trade policy negotiations shifted from the pursuit of globalization to regional agreements and bilateral relations. The largest of the regional agreements was initiated in 2012, when the African Union launched negotiations among its 55 member countries towards an African Continental Free Trade Area (AfCFTA). Agreement on a treaty was reached in 2019, and implementation began in 2021 towards lower trade barriers among all African countries. Bilateral policies also became much more important, including a series of tariff increases between the U.S. and China in 2018–2020 that redirected trade to different partners.

Bilateral disputes, known as 'trade wars', involve a sequence of retaliatory tariffs or quotas on imports of specific products. In 2018, the U.S. government argued that China had violated the intellectual property rights of U.S. companies, and raised restrictions on a variety of manufactured goods imported from China in response. China immediately retaliated with restrictions on its agricultural imports from the U.S., leading to a sequence of similar retaliations on other products than ended in 2020.

Trade wars with individual partners are not aimed primarily at protecting domestic producers, and their effects on each country depend on how easily traders can switch to other partners. For generic commodities with global markets such as feed grains, bilateral restrictions mainly lead to higher global transport costs as traders are forced to use longer or slower and more expensive routes. Announcements of Chinese tariffs in 2018 led ships traveling from the U.S. to turn in mid-ocean towards other destinations, and ships from South America turned towards China. For more specialized products, finding alternative suppliers takes longer and is more expensive.

One important purpose of the GATT and WTO is to offer less costly paths to dispute resolution, by specifying the scope, extent and timing of retaliatory tariffs that would be allowed when a country is found to have violated the treaty. For example, in 2002, Brazil lodged a complaint with the WTO that some aspects of U.S. cotton policies lowered world prices and harmed their farmers, in violation of the Uruguay Round agreement. The WTO panel agreed, authorizing a specific set of retaliatory tariffs that Brazil could apply against imports from the U.S. Those would have disrupted supply chains for many influential companies, so the U.S. agreed to settle the case with a $300 million payment to fund the Brazilian Cotton Institute (IBA) and thereby assist the farmers who had been harmed.

The deeper and longer-term purpose of trade agreements is to counterbalance political forces that lead governments to protect favored industries within their countries, at the expense of their own people. The political economy of trade policy leads to systematic patterns of agricultural protection, as revealed by the data in Fig. 11.5.

The variables shown in Fig. 11.5 are compiled by the Organization for Economic Cooperation and Development (OECD), an agency funded by its 38 member countries to provide independent policy analysis on many topics including food and agriculture. This chart shows the percentage of farm revenue attributable to either trade policy or domestic programs, a metric developed in the 1970s to add up the value of different kinds of assistance to farmers across Europe. This producer support estimate was originally known as the producer subsidy equivalent (PSE), and is available from the OECD for 23 countries shown in gray, plus the five highlighted, shown here from 1986 to 2021.

From the top left, in Japan almost 60% of farmers' income was attributable to policy intervention in 1986, declining gradually to about 38% in 2021. Almost all of this comes from trade restriction at the expense of consumers. Occasional opinion polls show that Japanese consumers favor restricting food

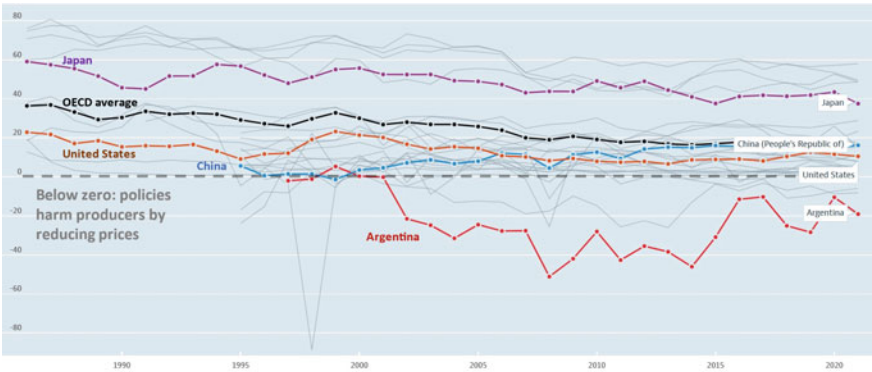

Fig. 11.5 Producer subsidies or taxation in selected countries, 1986–2021 *Source*: Reproduced from OECD, Agricultural support database. Gray lines show all 28 countries for which data are available, including the EU as one country. Values are the producer support estimate [PSE] sum of policy and program transfers to or from farmers, as a percentage of gross farm receipts. Details of methods and data sources are at https://data.oecd.org/agrpolicy/agricultural-support.htm, with updated versions of this chart showing other countries at https://data.oecd.org/chart/7dI9

imports even at their expense, which is understandable given the small cost to each consumer and their desire to maintain high farm incomes. The gray countries where an even larger fraction of farm income comes from farmers include South Korea and also Switzerland, Norway and Iceland, which are somewhat similar to Japan in terms of willingness and ability to pay high food prices in support of farmers. The OECD average of countries for which data are available was almost 40% in 1986, falling to 18% in 2020 and then rising to 23% in 2021 due to price fluctuations.

The U.S. level producer support was at 23% in 1986, declining to 10% of farm revenue in 2021. Unlike Japan, almost all of this comes from taxpayer support. The only major farm groups for whom higher revenue comes mainly from consumers are sugar growers due to import restrictions, and dairy due to domestic supply restrictions. For those commodities, the OECD estimates that the share of farm income due to policy in 2019–2021 was 45% for sugar growers of which almost all is due to higher prices, and 10% for dairy farmers of which about half is due to higher prices and the other half to government-funded programs. Wheat growers are also around the 10% while other crops such as corn at 7% and soy at 5% have that support entirely from program payments.

Producer support data in Fig. 11.5 shows how China had a near-zero level of assistance to farmers when their data begin in late 1990s through the early 2000s, rising to 16% in 2021. More dramatically, Argentina was also around zero in the late 1990s, but in the 2000s began imposing large taxes on exports of soybeans and quotas on export of wheat, maize (corn) and dairy, in an effort to collect government revenue and also keep domestic prices as low as possible during their recurring periods of economic crisis.

Each country's combination of policy instruments leads to a somewhat different set of impacts on consumers than on producers, as shown with the OECD's consumer support data in Fig. 11.6.

The data in Fig. 11.6 show the percentage of the value of raw farm commodities consumed within each country that is attributable to government policies. By analogy to the PSE, which is now known as the producer support estimate, this indicator is called the consumer support estimate (CSE). To indicate the level of assistance to consumers, the scale is reversed so that a positive number indicates consumer support through lower prices.

The name of the CSE indicator could be misleading in that the consumers of raw agricultural commodities are livestock growers, food manufacturers and industries such as biofuels, not final consumers of retail products for which ingredients may be a small fraction of the total price. In Argentina and the U.S., prices for most commodities are kept lower than they would otherwise be, by about 20% in 2021. China moved towards increasingly taxing its consumers to help its farmers and reached −14% in 2021, while the OECD average moved in the opposite direction from −30% in 1986 to −4% in 2021, and Japan's heavy taxation of consumers moved from −58% in 1986 to −33% in 2021.

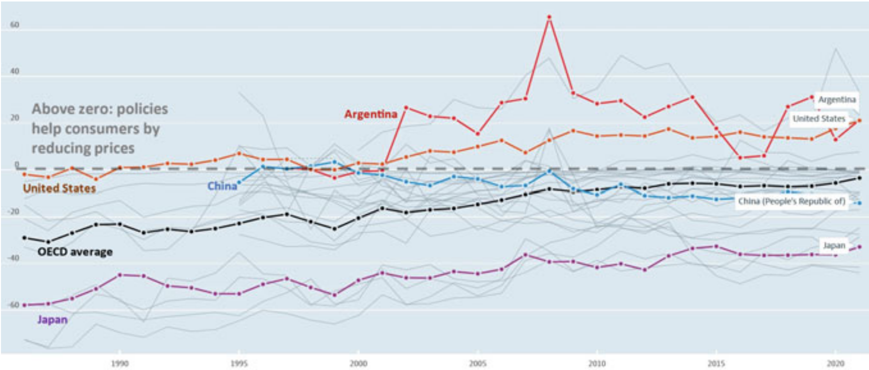

Fig. 11.6 Consumer support or taxation in selected countries, 1986–2021 *Source*: Reproduced from OECD, Agricultural support database. Gray lines show all 28 countries for which data are available, including the EU as one country. Data are consumer support estimate [CSE] totals of policy and program transfers to or from consumers, as a percent of agricultural product value consumed. Methods and sources are at https://data.oecd.org/agrpolicy/agricultural-support.htm, with updated versions of this chart showing other countries at https://data.oecd.org/chart/7dIk

For global monitoring over a larger number of countries, the available data have a shorter time period and less detail about each country than the OECD's agricultural policy monitoring reports. Also, in contrast to the PSE which was developed primarily to quantify government programs that help farmers and therefore expressed as a percentage of actual farm revenue with existing interventions, the global monitoring data are used mainly to monitor trade policy as is typically presented as a percentage of the product's opportunity cost without the policy. This percentage is the country's nominal rate of protection (NRP) to farmers when it adds up only the effect of trade restrictions at the country's borders, and the nominal rate of assistance (NRA) to farmers when it also includes the value of government programs and other measures to help farmers. For example, if farmers are growing a product that the country imports at a CIF price of $1 per unit with a tariff or quota that made the domestic prices $1.10, the tariff-equivalent NRP would be 10%. And if farmers grow 100 million units and the government also provides $5 million in subsidized inputs, that's another $0.05 per unit so the NRA would be 15%.

Data on tariff-equivalent effects of agricultural policies were first compiled in the late 2000s by the World Bank in a project on distortions to agricultural incentives. Updated versions of those data from the World Bank have been combined with OECD data and additional estimates from the FAO through a project with the International Food Policy Research Institute (IFPRI) known as the AgIncentives Consortium, which computed the regional averages shown in Fig. 11.7.

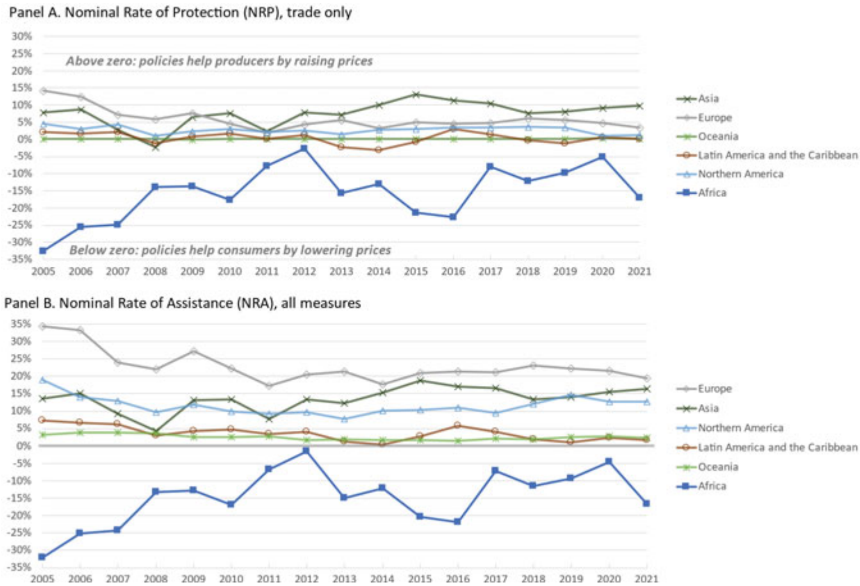

Fig. 11.7 Tariff-equivalent measures of agricultural policy support worldwide, 2005–2021 *Source*: Authors' chart of data from the AgIncentives Consortium [2023], using country observations from OECD, FAO, IDB and World Bank compiled for regional averages by the International Food Policy Research Institute [IFPRI]. Methods and more detailed data are available at https://www.agincentives.org

Starting at the top left of Panel A in Fig. 11.7, the overall average tariff-equivalent NRP for all of Europe was 14% in 2005, falling significantly due to reforms of the Common Agricultural Policy and other changes to 4% in 2021. Asia was around 8% in 2005, and fluctuated to end at 10% in 2021. North America had fluctuations around 2–5%, and Latin America had fluctuations around zero, while Oceania had an NRP very close to zero in all years. That region consists mostly of Australia and New Zealand which pursued their own 'unilateral' policy reforms towards freer trade in the 1990s, which helped spur economic growth in those countries but might not be politically feasible elsewhere.

The outlier region in Panel A is Africa, which had a large negative NRP throughout the period. Farmers received 33% less than what they would have been paid for their output in 2005, which fluctuated and ended at 17% less in 2021. Prices are reduced by trade policy when exports are taxed for the purpose of collecting government revenue, or restricted with quotas and other barriers to exports that keep prices low for urban consumers and industrial buyers inside the country. European colonial powers that ruled Africa from the nineteenth century into the 1960s imposed large export restrictions of this type, combined with policies designed to give farmers few options other than to continue growing the export crops that financed their colonial enterprises. After independence in the 1960s many African governments continued to restrict exports but used the funds for other things. In these contexts, where most workers are farmers and urban consumers are politically influential, continuing to limit agricultural exports was politically attractive even to independent governments. The benefits are highly visible and concentrated in cities, while the burden of taxation is spread through a small cost on each of many farm households who may not know that the low prices they receive are due to trade policy.

In Panel B of Fig. 11.7, the NRA includes not just the effects of trade policy in NRP, but also any domestic payments from government programs. That difference reveals how European payments raised total assistance to farmers above 33% in 2005, declining to 19% in 2021. Assistance in Asia fluctuated then rose to 19% in 2015 before ending at 16% in 2021, just above North America, while Latin America and the Caribbean as well as Oceania stayed much lower. In Africa there is very little program assistance to offset the large tax burden imposed by export restriction, so the NRA is similar to the NRP.

The high taxation of African farmers by their own governments shown here is sometimes done explicitly through export taxes, but more often it is done through government-owned enterprises in pursuit of direct control over the food supply. In some cases, there are export bans intended to help industrial food processors. An illustrative example is Senegal, where the French colonial government developed a large groundnut (peanut) sector for export, including the first local processing plant in 1920 to save transport costs by exporting oil instead of the whole grain. The government used state marketing agencies that set a single price for the entire country for the whole season, thereby excluding private traders who would otherwise buy from places and times with low prices to sell at other places and times, and they also blocked private exports to ensure that only colonial enterprises could handle the crop. After Independence in 1960, the new government eventually bought out the French processing and trading companies, but kept the processing plant operational in the belief that local industrial value added was preferable to exporting the raw grain. These processing plants have high operating costs, however, so their continued survival depended on restricting exports. As of late 2023, the government continues to restrict exports enough to keep those plants operational, despite the demands by farmer groups that they be allowed to export directly at the higher prices offered in trade.

11.1.3 Conclusion

The trends and patterns in farm support or taxation observed in recent years show how different political arrangements lead to different government policies, with large consequences for income distribution as well as economic growth in each country. The principle of comparative advantage shows how each population could gain by adjusting to trade prices, while also showing how openness to trade would disrupt existing businesses. Those distributional effects ensure that trade restrictions are often politically attractive despite missing out on potential gains from trade, and also reveal how governments can form treaties with other governments to maintain more open borders and thereby meet their political needs while also achieving their economic aspirations.

The era of globalization with rapid growth in trade volumes from the 1980s through the 2000s came from new technology that lowered the cost of transportation and communication, and also policy change that lowered government-imposed trade barriers. Some of that increasing political openness came from unilateral policy reforms, some of it came from bilateral and regional agreements and some from the global agreement to form the WTO in 1995. The swing towards global economic integration ended in the late 2000s, in favor of regional groupings such as the African Union's continental free trade area initiated in 2012 and signed in 2019. The future direction of trade policy is uncertain, but using economic principles and newly available data can potentially help civil society organizations and community leaders understand what is at stake and advocate for their interests.

11.2 Value Chains, Social Accounting and Institutions in the Food System

11.2.1 Motivation and Guiding Questions

The world food system is an interconnected web of national and local food systems, each with its unique characteristics. National food systems are shaped by country governments that control international trade, macroeconomic management and other decisions driving employment opportunities and income distribution, as well as national-level food and agricultural policies. Local food systems within countries are shaped by local governments. Within those systems, how do individual enterprises operate? How are individual food products grown, transformed and delivered to people, and what are the consequences of those activities for society?

The flow of an individual product from source to end-user is a *value chain*. In this section we introduce analytical methods used to understand value chains, and the societal *institutions* that shape how each value chain operates. By institutions we mean the organizational structures that govern the individuals and enterprises in a food system. These institutions may involve formal laws and organizational structures, or informal norms and practices. Each institution has its historical origins and is shaped by people's choices, for example the land tenure arrangements by which farm families might own, rent or otherwise gain access to resources for the farm they operate.

The value chain for each thing can be seen by tracing its physical flow downstream from origin to end-users, or the corresponding flow of purchases upstream back from end-users to the origins. Each item you ate yesterday typically had a mix of ingredients from different places, so tracing its origins would be like tracing the flow of water back upstream to its many sources. Each item produced on a farm last year could similarly be traced like the flow of water from a source out to its many destinations. Moving a food along the chain uses resources, measured in terms of value added as part of the circular flow of economic activity, which for environmental purposes can also be measured using life cycle analysis and social accounting for cost–benefit analysis.

The institutions that govern value chains, as well as the individuals and enterprises that actually handle each food along its value chain, almost all manage multiple foods at the same time. A few entities specialize in just one narrowly defined food such as coffee, but most individuals and enterprises diversify their operations to limit risks and benefit from economies of scope when the same facilities are used for different things. Each value chain is therefore part of a multiproduct web in which foods and resources flow to and from all parts of the food system.

By the end of this section, you will be able to:

1. Define and describe food value chains from farms to consumers, and the functions of enterprises along those value chains;
2. Define and describe horizontal and vertical integration by enterprises between and within value chains;
3. Describe the institutions and marketing arrangements along value chains used by farmers in origin regions, traders at and between terminal markets, and distributors to grocery outlets or food service providers; and
4. Describe how financial markets trading contracts for future delivery of farm commodities provide fluctuating forecasts of the product's cash price at the closing date of each contract.

11.2.2 Analytical Tools

Previous chapters have introduced the principal methods used in economics to explain, predict and evaluate each activity and their interconnections, using the individual choice diagrams for production and consumption, and the market diagrams for interaction of supply, demand and trade. In this chapter we provide some additional tools for visualizing each activity and describing the interconnections between them.

Value Chains and Institutions in the Food System

The circular flow of goods and services described in Chapter 9 on the economy is an interconnected web of many value chains. Each activity or enterprise uses the inputs it needs, and combines them to provide a value-added product as an input to other activities. From the perspective of each individual actor, what they use comes from an upstream source and flows on to a downstream destination. In some cases the product itself is unchanged, so value added is provided only through transport, storage and handling. In other cases the product is transformed by processing and packaging. Logistics of transport, storage and handling of a given product is generally described as its *supply chain*, while the term *value chain* refers to all aspects of a product's journey from origin to destination.

Value chain analysis in the food system allows us to distinguish between functions performed at different locations. These functions could all be performed by the same enterprise, for example by a farm that sells directly to consumers, but value chain analysis is most useful when functions are undertaken by separate enterprises with specialized structure and skills. Those enterprises then interact with each other through market transactions as illustrated in Table 11.2.

Vertical integration is when a single enterprise aims to directly control multiple functions along the chain from origin to destination. Horizontal integration is when a single enterprise expands to serve multiple value chains or a wider geographic area. The commercial success of vertically or horizontally integrated businesses depends on their ability to perform each function more cost-effectively than separate competing enterprises, each with their own structure and specialized skills adapted to their geographic location and other circumstances.

The alternative to vertical and horizontal integration is a sequence of markets along the value chain, in which specialist enterprises compete with

Table 11.2 Specialized functions, enterprises and transactions along food value chains

Specialized functions	*Enterprises and market transactions*
Dispersed in region of origin	
Farming and fishing	Producers sell to aggregators for onward shipment
Product aggregation	Aggregators sell to traders for onward shipment
At terminal markets and along transport networks	
Commodity trading and storage	Traders sell to each other, manufacturers or distributors
Food manufacturing	Manufacturers buy from traders or upstream sources
Food distribution	Distributors buy from manufacturers or upstream sources
Dispersed in destination regions	
Food service and retailing	Providers buy from distributors or upstream sources
Food consumption and nonfood uses	Consumers buy from retailers or upstream sources

each other to perform each function. The intermediate markets along a value chain could then be analyzed using the toolkit of supply, demand and trade models presented in previous chapters, revealing the potential for market failures that would affect the quality and price of products for every other stage of the chain. The institutions and policies governing the enterprises that perform each function, including the markets institutions for govern transactions between enterprises, determine the degree of quality assurance, price transparency and antitrust enforcement needed throughout the food system as a whole.

Individual enterprises in the food system often seek to analyze their own supply chains, looking for risks and opportunities to improve sourcing. Supply chain research looks upstream at where, how and from whom the enterprise's inputs are sourced, in contrast to marketing research that looks downstream at where, how and to whom the enterprise's products are sold. Supply chain analysis is sometimes focused only on private risks and opportunities affecting the enterprise itself, and many analysts are also concerned with the public health consequences or environmental, social and governance (ESG) impacts of how products are obtained and made.

Analysis of vertical integration in food supply chains can be traced back to the nineteenth-century French term *filière*, meaning a thread that can or should be followed. The *filière* approach to sourcing food ingredients was an important aspect of how France governed its colonies and overseas territories in the late nineteenth and twentieth centuries, identifying the most profitable and least risky places from which to source each product, and maintaining direct control over purchases from farmers, aggregation and transport to end-users in France or elsewhere. British and other colonial food systems were more likely to use markets with independent local traders, and the English term *value chain* emerged much later, regarding the need for large enterprises to make strategic decisions about where and how to source their inputs.

Each individual supply chain is embedded in a circular flow of economic activity at each location, drawing on natural resources in the environment and relying on infrastructure and other aspects of the macroeconomy. Those underlying resources are used by each value chain in ways that are governed by a set of institutional arrangements and organizational structures that regulate who can do what, where and when or with whom. Some institutions involve explicit legal rights and responsibilities, such as worker rights and titles for ownership of land that might or might not allow owners to subdivide and build or rent, while other institutions are informal arrangements that arise without needed to be codified into law, such as the practice of sharecropping by which tenants give landlords a fraction of the harvest each year.

All institutional arrangements are historical choices, made in response to geographic and other factors that influenced the costs and benefits of each approach. For example, in most of rural Africa until the late twentieth century, potential cropland was abundant relative to labor and the capital needed to use land productively, so there was little need or opportunity for people to buy or rent land. Plots for farming were allocated by community leaders in ways designed to maintain social cohesion and farming opportunities for each generation of new farm families. In contrast, by the early twentieth century East and South Asia was so densely populated from population growth and shrinking land area per farm that many farm families were too impoverished to own the land they farmed. Many were tenants who also borrowed money from landlords to repay at each harvest. In the Americas and Southern Africa as well as Australia and New Zealand, eighteenth- and nineteenth-century settlers from Britain and Europe had forcibly displaced native people and each settler farmer was granted a legal right to larger areas of land than they could plow. Land use depends on labor, including forced labor of enslaved people from Africa for plantation agriculture in the Americas, as well as the apartheid system used by settlers against the native population of Southern Africa, and the displacement and isolation of native people in the Americas. With sufficient political pressure these systems change over time, but they cast a long shadow over the land use and inequities we observe in each region today.

The individual enterprises that operate within each country's institutional framework vary greatly in size and scope, in ways illustrated by the food system diagram of Fig. 11.8.

The schematic diagram in Fig. 11.8 provides context for the functions listed in Table 12.1, and also for double-hourglass structure of the food system introduced at the start of our chapter on market power in Fig. 5.1. At the upstream end of each value chain are agricultural input and farm service suppliers, whose operations typically involve scale economies such that one or a few sellers provide inputs to many farmers at each location. Those farmers are drawn as a wider band to indicate the large and variable number

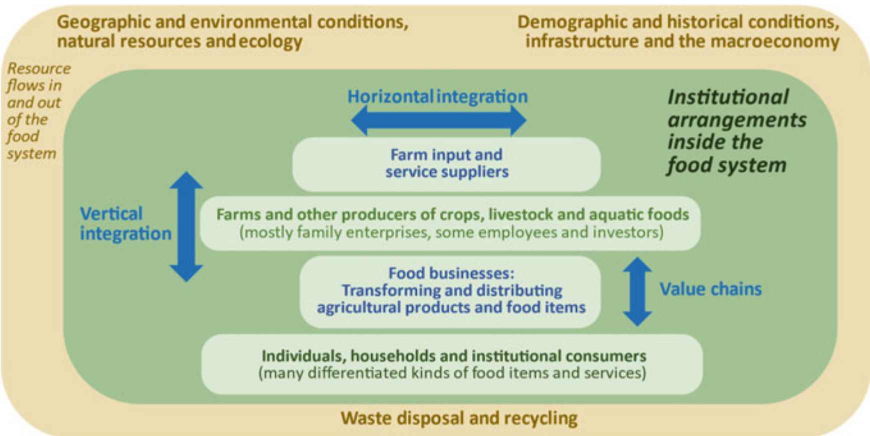

Fig. 11.8 Institutional arrangements and value chains in the food system *Source*: Authors' infographic, adapted from the nested framework of a social-ecological model showing each entity within its larger context

of individual enterprises in agriculture, most of which are self-employed families but sometimes include large-scale farms with a large number of workers per farm or fishing and livestock operation. Those producers typically then sell farm commodities and other products to business enterprises, whose scale economies are such that a few food businesses buy from many food producers and sell to many individuals and households or other end-users.

In the background of Fig. 11.8, behind all those individuals, households and enterprises, is a set of institutional arrangements in the food system, and around the food system there is a set of geographic and environmental conditions indicated at the top left, as well as a set of factors influenced by people listed in the top right. Environmental aspects of the food system include not only the natural resources used as inputs but also waste disposal and recycling of food loss and waste, shown at the bottom of the figure, with a note at the top left indicating the possibility of monitoring natural resource flows in and out of food systems, in addition to the value chains within each food system.

Value chains are shown at the right of the diagram, indicating the potential traceability of foods consumed back upstream to their origins on the farm. The double-hourglass part of this diagram was introduced as Fig. 5.1 to show how scale economies create the possibility of market power, and here we show that in the larger context of formal and informal institutions that help influence how enterprises operate inside the food system, and how they obtain and use natural resources.

Improving the social value of each food item calls for improvement at every stage of its value chain, involving different kinds of enterprises and transactions between them. Some items have only one link between initial producer and final consumer, for example at a farmer's market where growers sell directly to individuals. Opportunities for direct transactions of this type are a very attractive, high-value amenity for any community, but sales are typically season and farmers in each location can supply only some of the diverse foods that consumers want and need. More commonly there are multiple enterprises along the value chain, each undertaking different tasks and then selling onward to the next enterprise in the chain, calling for analysis and governance of how they operate and interact with the food system as a whole.

Horizontal Integration and Consolidation in Agribusiness and the Food Industry

Enterprises differ in how widely they operate across geographic locations and different kinds of goods and services. The commercial success of horizontally integrated operations depends on economies of scale and scope, referring to both the total size of the enterprise and the diversity of products that it sells. Horizontal integration can be cost-effective but leads to the risk that enterprises will be able to exercise market power, as explained in Chapter 5.

One source for scale economies not previously mentioned is the capacity and cost of facilities and equipment. The scale of any manufacturing or processing enterprise is influenced by the fact that expanding the size of a machine or the capacity of a facility generally reduces cost per unit of throughput. In chemical engineering and similar fields this is known as the six-tenths rule of cost reduction, whereby raising the capacity of a plant by 10% raises the total cost of its outputs by 6%. This rule of thumb arises because many costs rise with the surface area and hence the square of the diameter, length and height of things such as pipes and containers, while capacity rises with their volume and hence the cube of those dimensions. The six-tenths rule applies to expansion only up to the size limit beyond which the equipment might break, which is why innovations in metallurgy and equipment manufacturing have focused on stronger materials that increase the ratio of throughput to the quantity and cost of materials used.

The economies of scope that sometimes drive horizontal integration include the use of diversification to reduce enterprise risks, and the degree of complementarity between one activity and another. For example, meatpacking plants often combine a slaughterhouse with cutting and packaging a variety of products, from whole chickens and large cuts of beef or pork to final products in branded packaging for retail sale. Meatpacking enterprises may expand and diversify across locations and products for sale, but they almost never have their own tannery to sell hides and leather. The facilities and circumstances needed for a commercially successful tannery differ greatly from what is needed for meatpacking. That lack of complementarity implies that meatpackers either sell entire hides to a tannery, or dispose of them as waste if the cost of transport exceeds the product's value.

Economies of scale and scope are both important drivers of horizontal integration, and they may reinforce each other. For example, for much of agricultural history, selling crop seeds was an enterprise that offered only limited economies of scale. The six-tenths rule does not apply to most aspects of seed enterprises, which involves growing or contracting for others to grow the desired seeds, then ensuring that buyers can trust that the seeds being sold will germinate and grow to be the desired plant. In the U.S. and many other countries, seed houses were family enterprises that earned the trust of nearby farmers, and if successful they grew slowly to serve a wider area. In the 1980s the U.S. extended patent rights to plant biotechnology which led to greater concentration in the seed sector, and to horizontal integration with the large companies producing crop chemicals.

In the 1980s and 1990s when plant geneticists first used biotechnology in crop breeding they developed two main traits, insect resistance with genes from the *Bt* soil bacterium, and herbicide tolerance with genes from other soil bacteria. Those two genetically modified (GM) traits proved to be useful primarily in three main crops. The *Bt* trait was most valuable to control stem borers on cotton and soybeans in place of repeated pesticide sprays, and herbicide tolerance was useful mainly on soybeans and then cotton and corn, so that herbicide could be sprayed just once after the seed germinates to kill weeds without damaging the plant. That trait was engineered specifically to tolerate glyphosate, which had been sold under patent since the 1970s by a giant chemical company named Monsanto that had not previously been in the seed business, but they were able to acquire and invest in the development and sale of GM seeds in part to extend sales of glyphosate.

By the 2010s, the use of GM traits had created clear economies of scope between seeds and chemicals, driving even greater scale economies around complementarities between the two kinds of technology. By 2020, just two large seed-chemical companies sell more than half of all seeds for cotton, soybeans and corn, and together with two companies they dominate the global market for some other seeds. This very high level of concentration in seed supply results from horizontal integration with the chemical industry, and the interaction of scale and scope when producing and selling both kinds of inputs.

Many other examples of horizontal integration could be drawn from the agribusiness and food sectors of every country in the world. Some expansion occurs through innovation and investment in a successful new approach to each business, as in the example of Walmart's development of computerized and networked inventory control in the 1970s and 1980s, which allowed them to expand geographically at lower cost than other retail outlets. Expansion through mergers and acquisitions risks introducing more market power than cost reduction, leading to antitrust and competition policies designed to limit the degree of concentration in each market.

Vertical Integration and Control of Farm-to-Consumer Supply Chains

Many agricultural and food products have long value chains, flowing out from a few locations of geographically concentrated production to many destinations and geographically dispersed consumers. At the same time, there is an offsetting interest in short supply chains, including direct farm-to-consumer marketing, as well as vertical integration of long chains so that end-users have more control over the source of each product.

An extreme case is the market for lettuce in the U.S. In the 2022–2023 marketing year, about three-fourths of all U.S. lettuce in the cold winter months came from the irrigated low desert of Yuma County, Arizona, with the remainder coming from a similar environment in southern California and some also from Florida. During the spring and summer small-scale producers around the country serve their local markets. Seasonal production can be extended with greenhouses or hydroponic and aeroponic production inside climate-controlled buildings, but large-scale production for supermarkets and restaurants in the summer is mostly from central California.

Production is often geographically concentrated due to location-specific resources and infrastructure, and the resulting community of people with specialized knowledge and skills. Consumption tends to be geographically dispersed because consumers want greater dietary diversity and more stable supplies than farmers in their own location can produce. Economic growth leads some foods to have longer value chains, when investment in transportation infrastructure and production capacity allows some production locations to develop based on comparative advantage and specialized knowledge. At the same time, economic growth also creates opportunities for some short value chains, when consumers prefer products from their own community and local suppliers have sufficient capital to invest in producing near those consumers.

One concern about long value chains involves risk in production and transport. Concentrated sourcing makes it easier to trace outbreaks of foodborne illness or changes in supply back up the value chain, drawing attention and interest in all aspects of where and how the product is grown and distributed. To limit those risks, suppliers seek both diversification of origins and also greater control over each supply chain. Food consumers everywhere seek out products from their own community partly due to trust and accountability when buyers and sellers know each other, and partly due to the cultural and historical significance of food from their own region.

The structure of value chains involves not just distance but also the number and nature of transactions. Long value chains have existed since antiquity, for example ancient Rome used wheat and other products transported across the Mediterranean sea from North Africa and southern France. Transport over land is more difficult so ancient trade routes often depended on river systems, but high value spices and other products can readily be carried and herds of cattle have been moved through long trade corridors since long before the nineteenth-century rise of ocean shipping and railroads led to very long supply chains for many foods all around the world.

A typical supply chain structure involves farmers in a given area selling to a local aggregator who assembles the product for onward sale. In that initial stage, scale economies often lead to just one or a few buyers serving many farmers in a given location. Those farmers can sometimes form a cooperative to provide that service to themselves and limit the use of market power against them. Local aggregators may provide initial processing, storage and packing for pickup or delivery to long-distance traders, who specialize in transport from aggregators to a terminal market, for example in a major city, where the product may be sold to another long-distance trader serving a different terminal market. Each of these links in the chain may involve some degree of processing, storage and repacking to serve different end-users. Ultimately traders will sell in bulk to food manufacturers, or to distributors for onward sale in smaller volumes to food service providers and grocery outlets. Each link in the supply chain involves specialist providers of that particular kind of postharvest transportation and transformation.

Products sold along the chain from farmers to aggregators, traders, processors and end-users can be generic commodities when each shipment is sufficiently uniform to substitute for any other, or a differentiated product for which each shipment has its own unique quality and price. In some cases the exact same product can move as both a commodity and a differentiated item, for example when identical butter from the same dairy processor is sold in both generic and premium packaging. The product standards that define a commodity are based on a variety of attributes, including genetic traits and the product's condition. For example, in the U.S. there are six main classes of wheat, and each is priced based on protein content as well as moisture and other attributes.

Transactions between actors along the chain may be done privately, or in a market where prices and quantities are visible to the public. With private transactions, information about the sale may be a closely guarded secret that facilitates the exercise of market power, including price discrimination and cartel behavior. One prominent example in the U.S. involves the supply chain for poultry meat, much of which is sold under private contracts with a small number of poultry processors. Those processors had been voluntarily reporting the prices they were paying to a market newsletter published by the Georgia state department of agriculture, but in 2016 those prices were revealed to have been false. Subsequent lawsuits over secret monopoly pricing were settled in 2021, with one processor paying $75 million and another $221.5 million to its end-users. Price fixing cartels between two or more processors rely on them credibly revealing quantities and prices to each other, while keeping that information hidden from the public. In September of 2023 the U.S. government filed an antitrust suit accusing a private data provider of doing just that, serving as the intermediary for a cartel of meat processors to hold back supply and raise prices against end-users such as processed food manufacturers, grocery stores and restaurant chains.

The vulnerability of end-users to upstream problems along their supply chains can lead large buyers to seek control through vertical integration, buying out the intermediaries. This prevents market power being used against them, but raises the risk that they will have even more market power to use against farmers or consumers. Ultimately, the extent of vertical integration depends on the ability of the end-user to actually manage each activity along the chain, and the willingness of antitrust authorities to allow a large fraction of the market to be controlled by a single entity.

When separate enterprises control different links in the supply chain, growers and consumers both have a strong interest in price transparency and lower transaction costs among the intermediaries between them. Those goals are typically achieved by organizing a competitive market among traders at each terminal market or other location. Where those intermediary markets use auctions with bids and offers, the market operator is often itself a private enterprise, and there is competition among market operators. For example, in the U.S. there are over 2000 privately run cattle auction houses, each financed by fees on every transaction. Where markets host competing vendors selling side by side in a physical building or open space, the marketplace is more often built and managed by local government or a trade association which rents the space to vendors. Market spaces may also arise spontaneously when vendors cluster together in a neighborhood, as in the part of a city where fish traders might be located based on transportation or other advantages. How each market is managed can have a large impact on transaction costs, and the degree to which any individual or group of traders can exercise monopoly or monopsony power in that market.

Commodity Trading and Financial Markets

When sufficiently large volumes of a standardized commodity flow through a terminal market, it can be worthwhile to create a separate financial market in contracts for future delivery. The first well-documented futures market arose for rice in Osaka in the early eighteenth century, building on the earlier and still common practice of buyers writing forward contracts for purchase at a later date. A forward contract implies that the buyer will take possession of the product when that date arrives. In a market for futures, the contract itself is bought and sold, and only the final holder of the contract on its closing date actually takes possession of the physical commodity. The largest commodity futures markets in operation today are in Chicago, founded in the mid-nineteenth century.

Once people are trading commodity futures, derivative contracts based on future prices can readily be created. These include call options allowing the owner to buy or put options allowing the owner to sell, with each contract specifying an expiration date and the strike price at which the specified quantity could be bought or sold if the owner chooses to exercise their option. In financial markets, participants with 'long' positions are holding rights to sell and benefit if prices rise, while participants with 'short' positions need to buy and benefit if prices fall. The availability of derivative contracts allows producers and commercial buyers of each commodity to hedge the price risks imposed by their physical position in the market. For example, a grain processor or bakery that needs a large quantity of wheat every month starts with a short position in the physical market. That exposes them to the risk of price rises, so they can pre-purchase the product with forward contracts or buy futures to lock in the price they pay, giving them a long position in financial markets. Grain farmers can take the opposite side of that transaction, agreeing to a forward contract or selling futures and buying put options to set a lower limit on the price at which they will eventually sell, to offset the long position they hold prior to harvest. Hedging decisions involve an implicit prediction about price, and market participants as well as outside observers can use the same contracts to speculate about what they think the commodity's price will be in the future.

The use of commodity markets for financial speculation refers to buying and selling contracts with no intention to take physical possession of the underlying product. Each contract has a settlement date, however, at which point the holder is legally required to take possession. At that time the commodity's value depends on supply and demand for the physical product itself. The price of a futures contract can fluctuate before its expiration date but ultimately converges to the cash price for physical transactions on the contract's closing date. The price trajectory for a futures contract reflects evolving expectations about actual supply and demand on that closing date, starting from the contract's day of issue. Traders who expect scarcity of the commodity or inflation of prices in general will buy futures and call options, placing a bet that prices will rise. A group of such traders can bid up the futures price before its closing date, but if good harvests come in or inflation does not occur they will lose money when price at the closing date is lower than they predicted.

Aggregating the predictions of all market participants in a futures market provides useful but often unwelcome signals about future scarcity of a commodity, or inflation in general. For example, after a crop is planted, speculators who anticipate low yields based on crop growth and weather forecasts will buy contracts for delivery after harvest, bidding up the futures price. Market participants will respond with their own predictions, holding onto or buying up physical stocks, thereby raising the actual cash price in the pre-harvest period. Traders will also ship grain towards that destination. If the prediction is wrong and the harvest is normal, all of those market actors will lose money. Such mistakes do occur, where speculators are misled by erroneous predictions that cause a price swing which would not otherwise have occurred. But if the prediction is correct, the price rise after harvest will ultimately be smaller than otherwise, because market actors will have anticipated the problem, cutting back on consumption and bringing in grain from elsewhere. Economic analysis suggests that having a price forecast from the futures market is generally preferable to other ways to forecasting price, because each participant in the market has real money at stake.

A particularly dramatic aspect of commodity markets is the possibility that one or a group of participants can use contracts to buy up an entire harvest and hold it off the market to raise prices for what they sell, and also manipulate the timing of those sales. Gaining market power through financial instruments in this way is known as 'cornering' the market, by analogy to a boxing match. Efforts to corner commodity markets typically lose money in the end, because profits made on the initial high-priced sales are lost when the value of the remaining hoard declines as prices fall back to normal. For example, in 1989 a major soybean processor named Ferruzzi acquired a much larger share of Chicago futures contracts than it actually needed, leading to short-term profits when prices rose but large losses as prices dropped when Ferruzzi had to sell its remaining contracts.

A rare counterexample in which a trader exited their commodity contracts profitably occurred in the 1950s in the U.S. market for onions, a storable product with very inelastic demand whose prices can fluctuate greatly. Because fluctuating onion prices made both hedging and speculation attractive, the Chicago Mercantile Exchange introduced a futures market for onions in the 1940s. In 1955, a commodity trader and onion farmer named Vincent Kosuga partnered with a commodity trader named Sam Siegel to buy up a large fraction of all available onions in the U.S. They made some money from their initial long position, selling at high prices, and made even more by selling short and then provoking a sudden price crash. This rare example of successfully cornering a market was possible partly because of limited disclosure rules at the time about how much Kosuga and Siegel were buying or selling, and partly because high transport costs allowed Kosuga and Siegel to manipulate the market in Chicago with no competition from international trade. In response to the extreme price swing caused by Kosuga and Siegel having withheld supply and then flooded the market, U.S. legislators made onions the only commodity for which future trading is entirely banned, under the Onion Futures Act of 1958.

Industrialization and Farm Structure

Returning to the schematic diagram of the food system as a whole, both vertical and horizontal integration of value chains ultimately link back to agricultural production on farms, fisheries and livestock operations. As discussed in Section 2.2 on production systems, most field crops are grown by self-employed family farmers. Family farms differ widely in their land area and level of mechanization, the inputs they use and how they operate, including the use of forward contracts or other aspects of the business. What they have in common is self-employment of family members, typically living on or near their farm operation.

While nonfarm businesses that are often owned by outside investors and managed by full-time employees, the pattern of self-employment of farm families is remarkably consistent around the world as shown in Fig. 11.9.

The data in Fig. 11.9 come from national censuses of agricultural enterprises. Countries differ in how they define a farm, whether and how often they attempt a complete census or nationally representative survey of those farms,

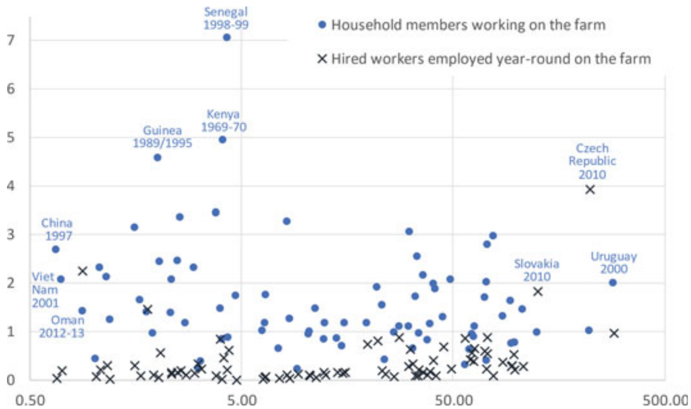

Fig. 11.9 Number of household members and year-round employees working on farms *Source*: Authors' chart of FAO data based on national governments' agricultural censuses, showing all 81 countries or territories for data are available on both household workers and employees. The earliest available is for Kenya in 1969–1970, followed by two in 1988 and 1989. Most are in the 1990s and 2000s, with the most recent in 2019 and 2020. The horizontal axis is farm size in hectares [log scale]. Countries shown have the three smallest and three largest average farm sizes, and the three largest family sizes. Updated datasets are available at https://www.fao.org/faostat/en/#data/WCAD

and what they ask about farms in those census or survey questionnaires. The data shown here are from the 81 countries for which the FAO's compilation of national census data includes both how many family members work on the farm, and also how many paid workers are employed for the entire year, in contrast to seasonal workers.

The horizontal axis shows farm size in hectares, using a log scale due to the exponential nature of variation. Circles show the number of family members, and X's show the number of employees. Most countries have an average of between 1 and 3 family members working on each farm, and an average of near-zero year-round employees.

The country names indicate the three smallest and three largest farm sizes, in terms of both farm size and number of family members. At the far-left, the smallest area of farms is China (surveyed in 1997) and Vietnam (in 2001) each had an average of 2–3 family members and almost no employees per farm. In contrast, the desert kingdom of Oman (surveyed in 2012–2013) had an average of 2.25 employees and 1.4 family members per farm, on just 0.9 hectares. Two other countries with year-round workers on farms are the formerly communist countries of Slovakia with 1.8 employees and 1 family member on 125 hectares, as well as the Czech Republic with 3.9 employees and 1 family member on 221 hectares. Having one or more year-round employees is clearly a result of unusual historical and political circumstances, not farm size.

Variation in the number of family members on each farm is also of interest, especially regarding large family sizes in the African countries shown. For Kenya and Guinea, these primarily reflect the large number of children as well as grandparents who may be listed as working on the farm. For Senegal, having an average of 7.1 working members arises due to the role of extended families living together in a single compound.

The relative absence of year-round employees does not mean a lack of hired workers. In fact almost all farming systems use labor exchange of some kind, typically for seasonal operations and tasks such as land clearing, building and repair of facilities, transportation, handling livestock and harvesting the crop. What those tasks have in common is that the farm owner can quickly observe whether the work was done, with some indication of how well the task was completed. In contrast, the management of field crops and tasks such as planting, weed and pest control or irrigation all influence the harvest in ways that are difficult to observe, so self-motivated workers can generally produce each crop at lower total cost than operations that rely on employees for those operations.

Farms where production operations are easier to supervise include greenhouses and horticultural operations, as well as many animal production systems. Those enterprises can often have several year-round employees. Another category of farm with many employees are plantation crops such as sugar, tea, rubber and oil palm which require immediate processing near the fields, using industrial machinery and facilities with large economies of scale. Sometimes these crops are grown by independent farmers around the central processing plant who are contracted for their crop, but such out-grower schemes typically give way to hired workers on a single plantation to ensure that harvests are tightly coordinated around their need for on-site processing. For plantation crops, processing plant operators need precise timing of delivery for each cart or truckload of raw material to the on-site factory. Furthermore there is only one buyer for the product, so if workers were operating their own farm on an out-grower basis they would be no less vulnerable to exploitation by plant owners. The geographic isolation of these workers, like those on commercial fishing boats, give them few alternatives and create risks of forced labor, wage theft, harassment and other forms of exploitation of concern to buyers and end-users of these products. Similar concerns arise regarding seasonal workers, and about child labor even on family farms.

Several important crops such as cocoa, coffee, cotton and tobacco had been grown on plantations in the eighteenth, nineteenth and early twentieth centuries, but those systems survived only as long as workers lacked civil rights and only a few owners had access to farmland. Across Africa, Asia, the Americas and elsewhere, once forced labor was ended most such plantations were no longer profitable. In some places, new governments actively subdivided land to accelerate the transition to more productive family farming. For cotton production in the U.S. after the Civil War, formerly enslaved people were given almost none of the land where they had been forced to work. They had to rent or buy it. The number of Black farm operators rose to a peak in the 1920 census, but the disenfranchisement and state-sanctioned violence of Jim Crow laws forced most of them off their land.

Beyond the number and average size of farms, how a country's land area is distributed among its population merits deep investigation. Land ownership and tenancy systems play an important role in how equitably, efficiently and sustainably the land is used. Land means much more to people than just the food it produces, and every country has its own unique history of possession and dispossession. For global comparison of land use distributions, the FAO compilation of agricultural census data is shown in Fig. 11.10.

The distributional data in Fig. 11.10 show the percentage of all farms in a country that are very small (0–1 hectare) on the left, and very large (over 500 hectares) on the right. In between there are three intermediate categories, small farms (1–5 hectares), medium-sized (5–50 hectares) and large (50–500 hectares). These thresholds and terminology are used here only for shorthand convenience. Whether a given area is adequate to provide a sufficient livelihood depends on many factors such as proximity to infrastructure and cities, soil quality and water management, availability of locally adapted seeds and farming methods. Even within a country, five hectares in a high-value location may be worth fifty hectares elsewhere. A farm of less than one hectare might be cultivated by hand, and could provide full-time employment above a country's poverty line only under very unusual conditions. In contrast, a farm

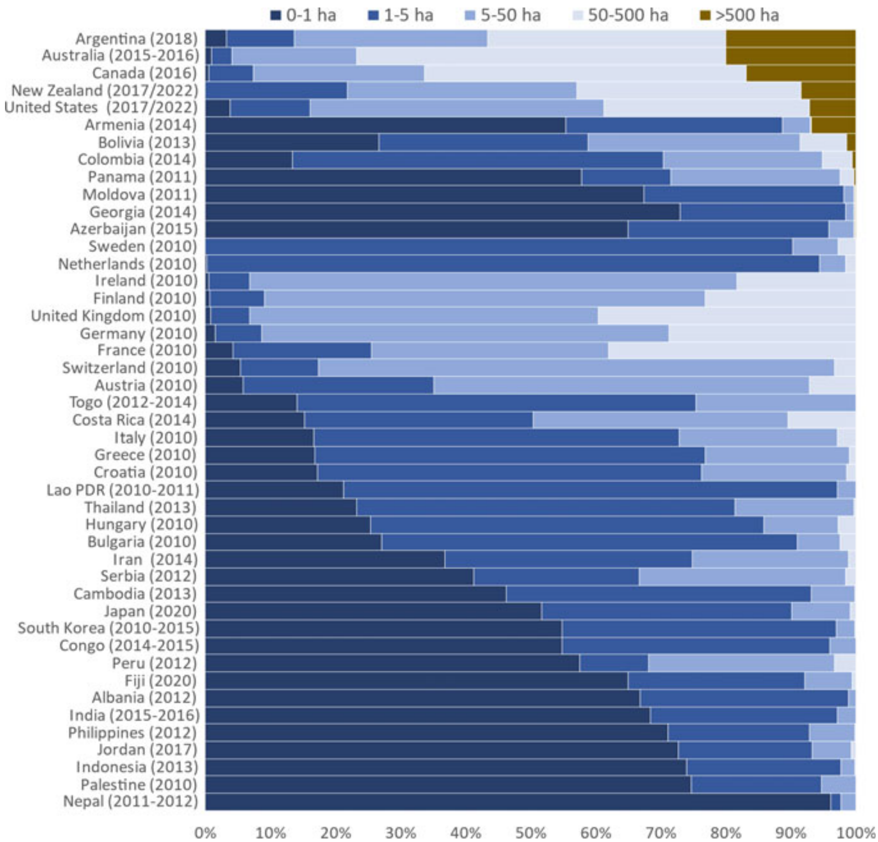

Fig. 11.10 Farm size distributions around the world *Source*: Authors' chart of FAO data based on national governments' agricultural censuses, showing all 46 countries or territories for which data are available on the number of farms by size category, in censuses conducted from 2010 to the most recent data from 2022. Countries are sorted by share of farms in the smallest and largest categories. Updated datasets are available at https://www.fao.org/faostat/en/#data/WCAD

of over 500 hectares might require a high degree of mechanization for one family to cultivate.

The chart shows all 46 countries for which the FAO compilation has an agricultural census conducted from 2010 to the most recent year of 2022, dropping the very small islands and territories with fewer than 50,000 farms. The countries shown vary greatly in terms of size, income level and location around the world. Sorting is done first on the percentage of very large farms at the top right, and then on the percentage of very small farms on the left.

Starting from the top of Fig. 11.10, Argentina and Australia both have about 20% of their farms in the very large category. In Canada that's 16%, and then New Zealand and the U.S. are at 8% and 7%. But the next country, Armenia, also has 7% of its farms above 500 hectares. Like the unusually large number of employees per farm in the Czech Republic and Slovakia shown in Fig. 11.9, that is a legacy of Eastern European transition from socialism. Armenia had been part of the USSR until its dissolution in 1991, and the Czech Republic and Slovakia were formed in 1992 with the dissolution of Czechoslovakia. Previously those systems had consolidated land in state farms, in Armenia's case with 7% of farms each having more than 500 hectares. Meanwhile the privatization process left a majority of farms (55%) in the 0–1 hectare range, and another third (33%) in the 1–5 hectare range. It is possible that all of the land in large farms is actually unproductive mountain areas used only for limited grazing, but three Latin American countries also have some of this distributional pattern. The next three are Bolivia, Colombia and Panama, each with some very large farms over 500 hectares, and also many very small farms, followed by Moldova, Georgia and Azerbaijan that were formerly part of the USSR. Their large number of very small farms reflects limited access to employment opportunities, with a share of very small farms that is similar to much lower-income countries such as India.

In the middle of the chart are nine northern European and Scandinavian countries with almost all of their farms in the intermediate range. These farming systems are unusual in that regard. The bottom half of the countries, from Togo and Costa Rica down to Palestine and Nepal, have increasingly large fraction of farms in the 0–1 hectare category. Of those, Peru is an unusual case with 58% of farms in that very small category, but also 3% of farms with over 50 hectares, and also 29% in the 5–50 hectares category, revealing a high degree of inequality. Again these differences could simply reflect differences in land quality, so with measuring the value of each parcel we cannot know much about the significance of the land use disparities shown in the chart.

From the bottom of Fig. 11.10 we have Nepal, where 96% of recorded farms are in the 0–1 hectare range, Palestine at 75%, Indonesia at 74%, Jordan at 73%, then the Philippines and India at 71% and 69%. These are all quite different from each other, but the large number of very small farms implies a clear need to focus on that scale of production. Some high-income countries such as Japan and South Korea also have large number of such farms, although often managed as part-time activities. Only two African countries have census data of this type, both relatively small coastal countries in West Africa: Togo (about 8.6 million people) and Congo (about 5.7 million; this is the Congo whose capital is Brazzaville, not the very large D.R. Congo to its east whose population is about 96 million).

Full Cost Accounting for Nonmarket Costs and Benefits Along a Value Chain

The differences and similarities in various aspects in every aspect of the value chains, institutions and farm structures of each country discussed in this section lead many analysts to seek more complete accounting of the nonmarket costs and benefits of the activities in the food system. Section 6.2 introduced the basic framework of cost-effectiveness analysis, used to analyze nonmarket impacts of a project or program. For what is sometimes called 'true cost' accounting, the incremental costs of each market transaction are added up to see differences in the total externalities or other nonmarket costs and benefits are imposed on other people. A useful accounting framework for true or full cost accounting is shown in Fig. 11.11.

The accounting framework in Fig. 11.11 is built around the tools used for cost-effectiveness and social cost–benefit analysis described in Section 6.2, adapted for use by analysts looking to evaluate the incremental impact on society of expanding or shrinking private-sector activities along a value chain. The framework's purpose is to help readers keep track of what could potentially be measured, recognizing that actual measurements for each activity of interest will be available for only some of the variables shown. This specific framework borrows from the many different approaches currently being used in terms of social accounting, true cost accounting or full cost accounting. These ideas differ from similar-sounding term, the social accounting matrix (SAM), which refers to the flow of funds through the market economy as shown in the circular flow diagrams of Section 9.1, in an expanded version of Table 9.2.

The framework refers to each item of interest, denoted with the subscript i, starting with the observed market price of that item $\mathbf{P_i}$. Full cost accounting

Opportunity cost or social value for one additional unit of an item along a food value chain (the i^{th} item)	**Impacts per unit of food**	**Valuation per unit of impact**	**Full cost or social value per unit of food**
Market price			P_i
External costs			
Environmental (e.g. social cost of carbon emissions)	a_{ij}	c_j	$a_{ij} \cdot c_j$
Societal (e.g. social cost of underpaying workers)	a_{ij}	c_j	$a_{ij} \cdot c_j$
Health (e.g., social cost of a diet-related disease)	a_{ij}	c_j	$a_{ij} \cdot c_j$
			$\mathbf{C_i} = \Sigma_j (a_{ij} \cdot c_j)$
External benefits			
Environmental (e.g., social gains from ecosystem services)	a_{ik}	b_k	$a_{ik} \cdot b_k$
Societal (e.g., gains from food system amenities)	a_{ik}	b_k	$a_{ik} \cdot b_k$
Health (e.g., gains lower micronutrient deficiency risk)	a_{ik}	b_k	$a_{ik} \cdot b_k$
			$\mathbf{B_i} = \Sigma_k (a_{ik} \cdot b_k)$
Transfers between people in society			
Taxes paid on sales of products, e.g., VAT			t_i
Subsidies received for production, e.g., PSE			s_i
Markup due to market power, e.g., monopolies			m_i
			$\mathbf{T_i} = t_i - s_i + m_i$
Social value per unit (market price, plus or minus nonmarket impacts, in pesos/kg)			$\mathbf{SV_i} = P_i - C_i + B_i - T_i$
Social cost/benefit ratio (market price, plus or minus nonmarket impacts, as a unit-free ratio)			$\mathbf{SCB_i} = (P_i + C_i + s_i)/(P_i + B_i + t_i + m_i)$

Fig. 11.11 Social accounting for environmental, social and health impacts along a value chain *Source*: Authors' synthesis of social cost–benefit concepts applied to true cost accounting, full cost accounting and social accounting for enterprises, for example as part of environmental, social and governance [ESG] or health impact accounting

then asks what externalities and other nonmarket costs and benefits are associated with one more unit, above and beyond that market price. Interest in true cost accounting is driven primarily by the need to account for environmental externalities, including especially the first and usually most important example which is impact on climate change measured as the social cost of carbon-equivalent emissions. There might also be external costs associated with water or air pollution. The next line lists societal impacts that analysts could include, such as the harms to a community from having some workers along the value chain who are unjustly exploited. The third kind of externality is a set of health costs associated with one more unit of the item, such as increased risk of a diet-related disease.

Each specific kind of externality is given a subscript j, so as to look for evidence about the quantity of that externality from one more unit of i, and also the value per unit of that externality. By convention, the amount of damage is denoted as a_{ij} and the cost per unit of damage is denoted c_{ij}. For example, the manufacturing and distribution of an additional bottle of soda might be estimated to cause additional carbon-equivalent emissions of 0.5 kg CO_2-eq, so one bottle per day causes an annual amount of $a_{ij} = 0.5*365 = 182.5$ kg. The social cost of carbon was most recently estimated by the U.S. Environmental Protection Agency (EPA) at $51 per ton, or roughly c_j = $0.05 per kg. The resulting social cost per year of a daily soda is $a_{ij} \times c_j = 182.5 \times 0.05 =$ $9.13 per year.

One feature of this accounting framework is that it explicitly distinguishes between the amount of each harm or benefit and its cost per unit. The amount of CO_2-equivalent gases emitted per bottle produced would be estimated using life cycle analysis (LCA), while the social cost per ton of CO_2-equivalent emission would be obtained from cost–benefit analyses used by agencies such as the U.S. EPA. Each variable might change with new information, and the analysis can be updated accordingly.

Another feature of this accounting framework is that it shows how the exact same concept can be used to add up various other aspects of the value chain, including the external benefits from a socially desirable activities in the value chain. Many kinds of farming have environmental benefits, or create desirable amenities like urban green space, or generate health gains. In each case there would be an amount of that benefit denoted as a_{ik} and the gain per unit of that benefit of b_k.

A third aspect of the framework is to recognize that market prices do not represent society's opportunity cost when activities along the value chain pay taxes to fund other things in society, receive subsidies from other people in society or involve market power such that prices are not equal to marginal cost. If the market price of the ith item includes t_i taxes paid to other people within the country, the cost to society of one more unit is actually P_i minus t_i, and similarly for the other factors.

The net result of the framework is to recognize that each unit has a social value per unit equal to the sum of all costs minus benefits, and that can also be expressed as a unit-free social cost/benefit ratio as discussed for project and program analyses in Section 6.2. As with any real-world application, a central question is what data might actually be available for which of the variables. The accounting framework can be used with just one type of nonmarket impact, or many.

For the social value of products from a value chain to show the causal impact of one more unit, the amounts and costs of nonmarket impacts would have to show the marginal effect of just the one additional unit. In practice, real-world data generally refers to the total or average of all units, and estimating marginal cost is not feasible because it would require building a detailed simulation model of the entire value chain.

Social accounting reveals opportunities to improve outcomes by addressing each market failure that generates externalities or allows market power. The institutions that govern transactions between enterprises along the value chain, and govern the operations of each enterprise, are societal choices made through the policies and programs of government and other organizations. Reducing both market failure and policy failure aligns observed prices with societal needs, driving market outcomes towards more sustainable, inclusive and health-supportive food systems.

11.2.3 Conclusion

Each food item we might eat comes to us from a farmer through a value chain, with each link along that chain bringing connections to all other aspects of the interconnected food system. This section introduces ways of seeing the individual elements of every country's agriculture and food system as part of a larger whole, by tracing what is consumed back upstream to its origins, and tracing what is produced downstream to its destination. Every food value chain is shaped by a country's institutions, which include legal and civil rights as well as traditions and social conditions that drive land use, worker rights and the structure of food enterprises. Those institutions are social choices, which vary in response to the opportunities and constraints created by both natural resources and investments that create new opportunities.

Individual enterprises in the food system often seek horizontal integration across value chains and a wider geographic extent of their activity, diversifying to limit the risks they face and using any available economies of scale and scope to reduce their cost of production per unit of goods and services they supply. Horizontal integration by intermediaries in the food system creates opportunities for them to exercise market power against others upstream or downstream in each value chain where they work. In response to that, and also in response to their own risks and market opportunities, enterprises also seek vertical integration up and down the value chain, gaining more control over the sourcing and uses of what they buy and sell.

Economic analysis of value chains reveals the role of both horizontal and vertical integration in how value chains are organized, and the ways in which longer or shorter value chains with different structures pose different risks and offer different kinds of benefits. For items involving a standardized commodity, financial contracts such as futures and options provide continuously updated forecasts of future prices, reflecting both that commodity's relative scarcity and a forecast of inflation in general.

Value chain analysis is helpful not only to understand the price and quality of products being bought and sold, but also to measure the nonmarket costs and benefits that could be added up in an overall social accounting of that activity's net social cost/benefit ratio. We may not yet have all the data we need to reliably compare the social impact of all activities, but the insights from these analytical methods show us where to look and how to interpret what we see.