CHAPTER 6

Food Supplies and Food Security

There has been debate over whether food supplies can expand sufficiently to meet the demands of an ever-increasing population since at least 1798, when the English political economist Thomas Robert Malthus published his *Essay on the Principle of Population.* According to Malthusian theory, populations grow exponentially but food supplies grow only arithmetically; at some point, therefore, the human population should outgrow its ability to feed itself. Since Malthus, a large body of literature has explored the interplay between technology, population, agriculture, economic growth, and income.[1] For most of human history—and certainly in Malthus's time—income per capita was basically stagnant. This is no longer true. The modern era is instead characterized by rapid economic growth and diverging growth and income trajectories across countries.

Nowadays the issue of food security no longer centers around food supplies—that is, the ability of humankind to produce enough food—but rather on people's access to adequate calories and nutrition.[2] As such, food security is mainly perceived as an issue facing poor countries, but the issue is broader: developments in food markets are far-reaching and indicative of structural developments at the global level.[3] Rapid growth in emerging markets, the evolving size and demographic structure of the populations of countries at every level of economic development, and technological innovation have and will continue to shape global food markets, including the structure of agriculture and the demand for food products. Furthermore, food markets are segmented and subject to multifaceted distortions created by investment and trade. This chapter takes an in-depth look at recent developments in and the likely future evolution of global food markets and discusses the implications for food security. The chapter addresses the following questions:

- What is special about food markets?

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[1]See among others Galor and Weil (2000); Galor (2005 and 2011); and Gollinand, Parente, and Rogerson (2002).

[2]According to the World Food Summit (1996) declaration: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life."

[3]See Arezki and others (2016) and references therein for a discussion on food price fluctuations and their consequences.

- What are the drivers of food production and consumption?
- How has global food trade evolved?
- What are the risks to food security?

WHAT IS SPECIAL ABOUT FOOD MARKETS?

"Food" is an edible or potable substance that helps sustain life. Food crops include cereals including wheat, maize, oats, and rice; fruits and vegetables; meat; seafood; beverages, including coffee, tea, and cocoa; oilseeds such as soybeans and groundnuts; and sugar.[4] These categories differ in a variety of ways in terms of nutritional value, perishability, and storability.

As an economy develops, a smaller share of the population works in agriculture, but farming remains the primary source of income for more than 750 million people—that is 30 percent of the world's workforce. In sub-Saharan Africa agriculture employs 60 percent of the workforce (World Bank 2015a). Many millions around the world survive through cash cropping or subsistence farming. The economic process of structural transformation, which induces labor to flow from the agricultural sector (low productivity) to the industrial sector (high productivity), explains most of the rapid increase in aggregate productivity since the industrial revolution (Duarte and Restuccia 2010).

Unsurprisingly, most food products are consumed domestically—about 85 percent of food is produced in the country where it is consumed according to the World Bank (2015a). The differences in the trade patterns for various food products depend, among other things, on whether they are cash crops. Changes in transportation technology and costs have shaped the degree to which global commodities markets are integrated, including markets for food products that initially had very limited geographical reach. The transport changes occurred in two stages (Radetzki 2011). The first occurred during the latter half of the 19th century and included the introduction of refrigerated ships which enabled long-distance transport of meat and fruit. The second stage began in the 1950s but came to fruition in the 1970s and involved the introduction of huge specialized bulk carriers, along with the concomitant loading and unloading facilities in major harbors. This enabled economic transport of low-value products across vastly extended distances. The result was a further dramatic decline in the cost of shipping—particularly for extended, transoceanic transport routes—which in turn led to a convergence of food prices across regional markets.

The extent to which international price variations are transmitted across borders is often determined by taxes, subsidies, price controls, weak market integration, and local distribution costs. In general, the transmission of international price fluctuations to domestic prices is minimal, but not insignificant. In advanced economies, the average long-term pass-through of a 1 percent food

[4]Some of the aggregate figures presented here also include nonedible agricultural commodities.

price shock to domestic food prices is about 0.10 percent, and it is about 0.15 percent in emerging market economies.[5] For this reason, and because most food production is consumed domestically, local agricultural and weather conditions have the most significant effects on domestic food prices.

Food has long been a sticking point in global trade negotiations, including in talks over tariff and nontariff barriers, despite the fact that agricultural trade represents only 8 percent of merchandise trade by value according to the World Trade Organization (WTO 2015). Tariff and nontariff barriers have often been motivated by concerns over food sovereignty and by efforts to protect the livelihoods of domestic farmers. The Doha Development Round of trade negotiations, or Doha Development Agenda (DDA), under the WTO stalled in July 2008 as a result of disagreements over agriculture. More recently, exporters in both advanced and developing economies have opposed a proposal under WTO consideration for a Special Safeguard Mechanism that would allow developing economies to take contingency restrictions against agricultural imports if those imports injure domestic farmers

The rationale for the Special Safeguard Mechanism is to counterbalance official support for agriculture in exporting countries. Over the past two decades, direct agricultural support has declined in the advanced economies of the Organisation for Economic Co-operation and Development, but it has ramped up in emerging market economies, which have largely switched from taxing their farmers to providing them direct support (Figure 6.1). Historically, in advanced economies the distortions tend to favor farmers, whereas in developing economies they tend to favor urban consumers at the expense of small farmers (Anderson 2016). All countries continue to have a strong anti-trade bias in the structure of assistance to their agricultural sectors (Anderson 2016).[6] Trade policy instruments, such as export and import tariffs, subsidies, and quotas, have serious distributional consequences for consumers. Markets that are especially distorted include those for soybeans, sugar, rice, wheat, beef, pork, and poultry (Anderson, Rausser, and Swinnen 2013).[7]

WHAT ARE THE DRIVERS OF FOOD PRODUCTION AND CONSUMPTION?

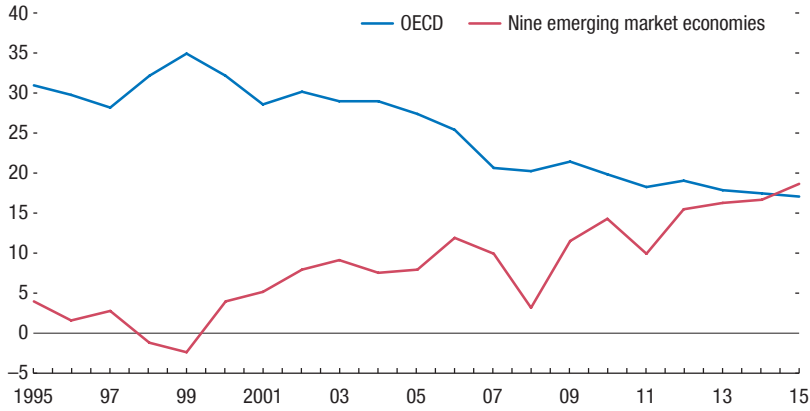
The main production and consumption centers for food are concentrated in a few countries, but they often overlap; the location of production centers varies

[5]See also Furceri and others (2016).

[6]Available data from the World Bank's World Integrated Trade Solution on the evolution of import tariffs on food products indicate that they fell from 22 percent to 11.5 percent between 1991 to 2014. Tariffs did not increase in any region. However, tariffs remained especially high in East Asia at 30 percent. In North America tariffs were the lowest at around 8 to 9 percent. These results are based on effectively applied average import tariff data for food products (in percent) calculated by aggregating, over all trading partners, the lowest applicable tariff for each partner.

[7]Cotton markets are also severely distorted.

Figure 6.1. Producer Support Estimate
(Percentage of gross farm receipts)



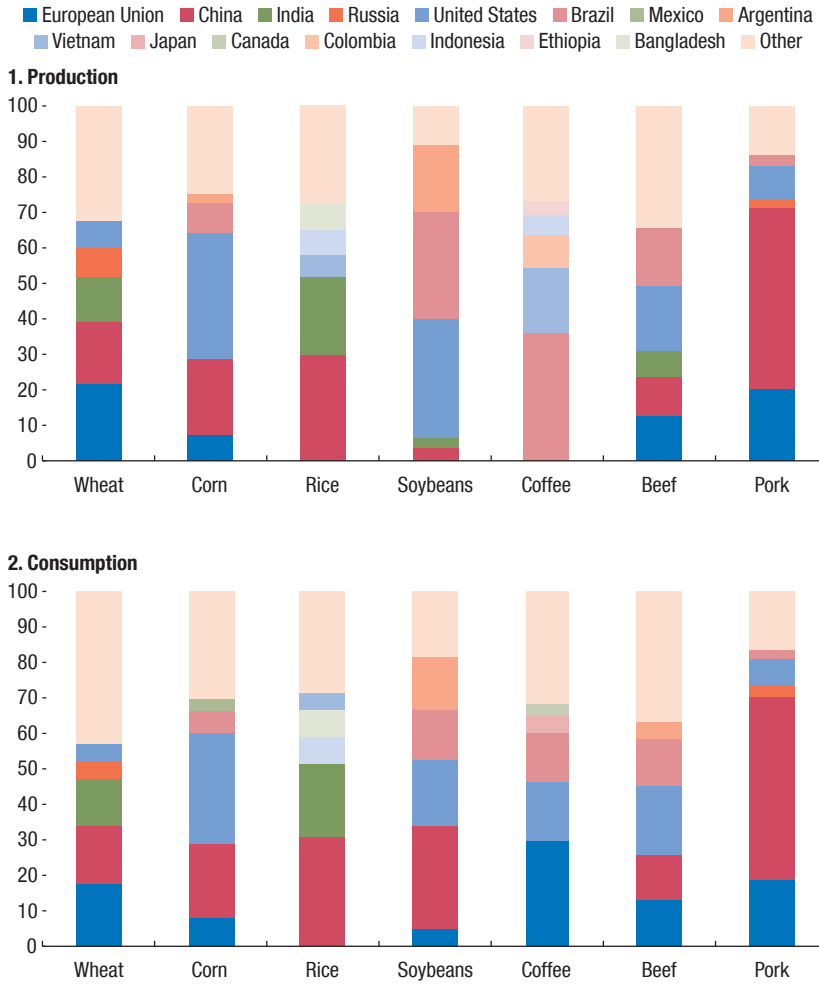
Source: Organisation for Economic Co-operation and Development (OECD) 2016, Producer and Consumer Support Estimates, Agriculture Statistics (database).
Note: OECD country classification is based on current membership. Emerging market economies are Brazil, China, Colombia, Indonesia, Kazakhstan, Russia, South Africa, Ukraine, and Vietnam. Vietnam is included from 2000 onward.

considerably with the type of food under consideration (Figure 6.2). For example, China is both a large consumer and a large producer of rice, pork, and soybeans, the latter a key animal feed. The United States is both a large producer and a large consumer of both corn and beef, and the European Union is the same for wheat. Of course, many raw food products are key intermediate inputs to the agro-industrial production of processed food products, including those for export.

Global food demand could double by 2050 compared to 2005; dietary shifts will account for around 70 percent of that increase, and global population growth will account for the remaining 30 percent (Tilman and Clark 2015). In general, population growth drives food consumption levels, and income growth reorients the composition of demand (Figure 6.3). There is a strong relationship between income per capita and consumption of meat protein, refined sugars, animal fats, oils, alcohol, and total calories (Tilman and Clark 2015). A case in point is China. China's remarkable economic growth over the past thirty years brought sustained increases in consumer income, and the Chinese have moved away from staples such as grains and rice, and toward a more diversified and higher-quality diet.[8] There are of course different preferences in individual countries which cause income growth to have varying effects on the composition of food demand. For

[8]In China, per capita food consumption of cereals decreased by 7 percent, and consumption of sugar and vegetable oils increased by 14 and 16 percent, respectively. Consumption of protein increased as well: meat by 37 percent and seafood by 42 percent. The increases in fruit and milk consumption were especially dramatic, both increasing by 115 percent.

Figure 6.2. World Food Production and Consumption by Country, 2015
(Percent of world production or consumption)

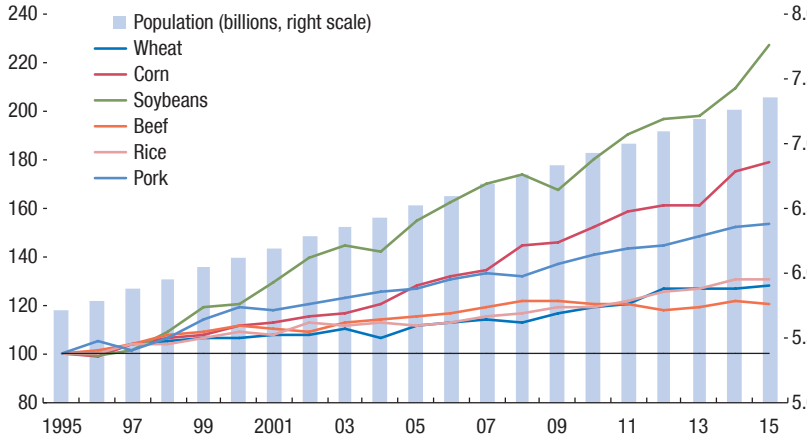


Sources: US Department of Agriculture; and IMF staff calculations.

example, India is a major exception to the general trend toward higher meat consumption, a reflection of religious traditions that favor vegetarianism.

Another driver of demand for food, in addition to population and income growth, is the use of agricultural products, especially grains, for nonfood uses such as animal feed and fuel. For example, some types of biofuels are produced from grain (for example, ethanol from corn). The use of biofuels has grown exponentially over the past decade, and this has pressure on food markets and has been blamed for food price increases (Chakravorty, Hubert, and Marchand 2015).

Figure 6.3. Population and World Food Consumption
(Index, 1995 = 100, unless noted otherwise)



Sources: US Department of Agriculture; World Bank, *World Development Indicators*; and IMF staff calculations.

The availability of arable land and certain types of technology and equipment also drive food production levels. Most of the unused land that is suitable for agriculture is located in developing regions—primarily sub-Saharan Africa and South America, as shown in Table 6.1. The global population is forecast to reach 9.7 billion by 2050, up from 7.3 billion in 2015 (United Nations 2015). Almost half of this population growth—1.3 billion people—will occur in Africa, with Asia adding an additional 0.9 billion people. This population growth will require increasing food calorie production by 70 percent by 2050 (International Food Policy Research Institute 2016). If all unused land were put into service by then, all else equal, total food production would help feed 9 billion people—far fewer than the expected global population of 9.7 billion. It is important to note that these rough calculations leave aside other factors that could either increase overall production such as technological innovations or reductions in food waste, or decrease it, such as warmer temperatures, water shortages, or land degradation.

The food supply increases that will be necessary to feed a growing global population should come mostly from productivity increases. Land use expansion for agriculture should be limited to the extent possible to ameliorate environmental and social concerns such as biodiversity loss, ecosystem degradation, increased carbon emissions, and conflict over traditional land-use rights. The challenge therefore, is to increase productivity on currently cultivated land and slow the rate of land degradation and deforestation. The potential to increase agricultural productivity is especially high in sub-Saharan Africa, where yields are 50 percent below potential levels (Fischer and Shah 2011).

TABLE 6.1.

Used-to-Available Land by Region, 2013

(Thousands of hectares)

	North Africa	Sub-Saharan Africa	South America	North America	Europe	Oceania	Asia	World
Used Land	46,151	221,805	192,393	205,091	292,457	48,912	568,454	1,575,263
Unused Suitable Land	46,595	162,198	130,946	7,242	27,189	15,628	13,392	403,190
Total Available Land	92,746	384,003	323,339	212,333	319,646	64,540	581,846	1,978,453
Ratio Used/Available	0.50	0.58	0.60	0.97	0.91	0.76	0.98	0.80

Sources: Food and Agriculture Organization of the United Nations (FAO), FAOSTAT and GAEZ; and IMF staff calculations.

Notes: Used land is the total of arable land and land under permanent crops, from FAOSTAT. Unused suitable land is calculated from GAEZ. Arable land is land under temporary agricultural crops, temporary meadows for mowing or pasture, under market and kitchen gardens, and temporarily fallow (less than five years). Land under permanent crops is land cultivated with long-term crops that do not have to be replanted for several years (such as cocoa and coffee); land under trees and shrubs producing flowers, such as roses and jasmine; and nurseries (except those for forest trees, which should be classified under "forest"). Permanent meadows and pastures are excluded from land under permanent crops. Unused suitable land is land that is suitable for agriculture, not forested, not protected, and not currently in use. Land is considered suitable if it is ranked by GAEZ as highly or very highly suitable for 1 crop out of 5 (maize, soybeans, wheat, sugarcane, palm oil).

HOW HAS GLOBAL FOOD TRADE EVOLVED?

In recent decades the patterns of global food demand have shifted more than the patterns of global food supply. As for other commodities, demand for food has shifted from the western hemisphere and Europe toward Asia because of differences in population growth that affect the level of demand and changes in income that affect the composition of demand. The supply shift from advanced economies toward emerging market and developing economies has been less pronounced for food than for other commodities such as minerals and metals. Although some emerging markets have increased their shares, the lion's share of global food trade is still sourced from advanced economies (Table 6.2). That is true despite potentially high returns on capital invested in the agricultural sector in many developing economies which would justify an inflow of capital into agriculture in those economies (see, for example, Gollin, Lagakos, and Waugh 2014a and 2014b).

There are wide gaps across countries in agricultural yields, which is a measure of land productivity defined as crop production per unit of land under cultivation (Table 6.3). These gaps reflect multifaceted impediments to investment and technology transfers in the agricultural sectors of developing economies. There is limited evidence of any convergence in the levels of agricultural productivity in those economies with the levels in advanced economies. The example of maize demonstrates the huge disparity between agricultural yields in the United States and in sub-Saharan Africa (Figure 6.4). There was a spike in large-scale, cross-border land acquisitions after food prices rose rapidly following the food crisis of 2007–08. This suggests that capital has started to flow from advanced economies into the agricultural sector in developing economies, but also reveals some important fault lines between investors and recipient countries (Box 6.1). Specifically, because many of these land deals occur in countries that are "food insecure," the detrimental effects of a future food crisis could be amplified. Also, it is not assured that new investors will help local producers integrate into existing supply chains, invest in local infrastructure or other public goods, or adequately compensate displaced land users.

TABLE 6.2.

Food Exports
(Share of global exports)

Region	1990	2000	2013
OECD	0.7766	0.7406	0.6240
Non-OECD	0.2234	0.2594	0.3760
Brazil	0.0236	0.0292	0.0661
China	0.0370	0.0411	0.0393
India	0.0051	0.0103	0.0263
Argentina	0.0258	0.0281	0.0262
Indonesia	0.0046	0.0108	0.0224

Sources: Food and Agriculture Organization of the United Nations (FAO); and IMF staff calculations.
Note: Food refers to food excluding fish aggregate from FAO. OECD and Non-OECD country classification is based on current membership. OECD = Organisation for Economic Co-operation and Development.

TABLE 6.3.

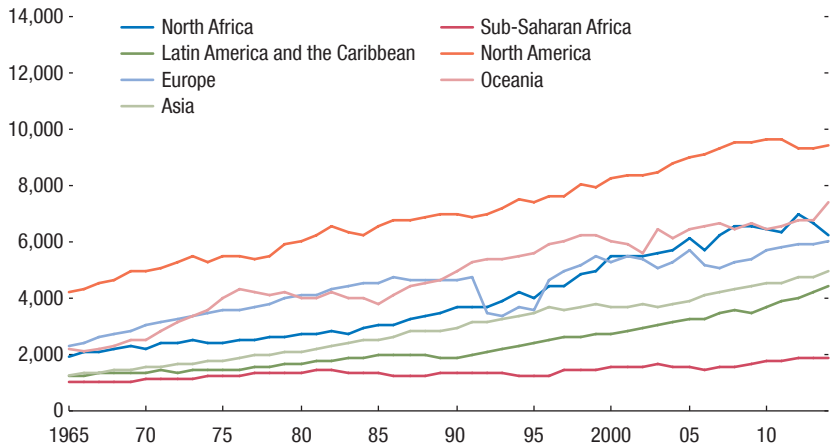
Weighted Average Yield of Crops
(Ratio relative to highest producer)

	North Africa	Sub-Saharan Africa	Latin America and the Caribbean	North America	Europe	Oceania	Asia
Maize	0.60	0.19	0.43	1.00	0.56	0.77	0.48
Rice	0.88	0.22	0.48	0.81	0.59	1.00	0.44
Soybeans	0.82	0.40	0.88	1.00	0.63	0.68	0.42
Wheat	0.63	0.60	0.65	0.71	1.00	0.48	0.73

Source: Food and Agriculture Organization of the United Nations (http://faostat3.fao.org/download/Q/QC/E).
Note: The table shows the weighted average yield of crops by region, normalized relative to the highest producer. The average yield is weighted by the area of harvested land: weighted average yield = $(\Sigma_i(\text{area}_i \times \text{Yield}_i)/(\Sigma_i(\text{area}_i))$. Yield is in hectograms/hectare; area harvested is in hectares.

The lack of net capital flows to developing economiesis not specific to the agricultural sector (Alfaro, Kalemli-Ozcan, and Volosovych2008). In many ways, the myriad factors deterring investment in agriculture are emblematic of the multifaceted challenges these countries face in improving their institutions overall. There is ample evidence that agricultural development is greatly affected by the rate of technology adoption (or lack thereof) and by human capital and credit constraints (see for instance, Besley and Case 1993; Foster and Rosenzweig 1995; and Dercon and Christiaensen 2011). Other factors that limit agricultural investment include a lack of adequate infrastructure (Donaldson and Hornbeck 2016), expropriation risks (Jacoby and others 2002), and land tenure issues (Besley and Burgess 2000).

Figure 6.4. Maize Yield
(Kilograms a hectare)



Sources: Food and Agriculture Organization of the United Nations; and IMF staff calculations.
Note: Yield refers to a five-year moving average. Oceania includes Australia, Fiji, Guam, Micronesia, New Caledonia, New Zealand, Papua New Guinea, and Vanuatu.

Box 6.1. A Global Rush for Land

Against the backdrop of increasing global demand for food, there has been growing interest on the part of governments, agribusinesses, and investment funds in acquiring long-term property rights or leases over large areas of farmland, mostly in developing economies (Arezki, Deininger, and Selod 2013). Most of these land acquisitions have been in food-insecure countries that are in dire need of investment in the agriculture sector. These deals could lead to positive or negative outcomes. This box presents evidence related to these transnational land acquisitions and discusses the policy implications.

What Drives Large-Scale Land Deals?

The term "land deal" refers to a large-scale, cross-border acquisition of land, typically at the expense of smallholder production or greenspace. Such a deal is defined as an intended, concluded, or failed attempt to acquire land through purchase, lease, or concession that meets the following criteria: (1) it entails a transfer of rights of use, control, or ownership of land through sale, lease, or concession; (2) it was initiated since the year 2000; (3) it covers an area of 200 hectares or more; and (4) it implies the potential conversion of land from smallholder production, local community use, or important ecosystem service provision to commercial use.[9] The global food crisis of 2007–08 led to a massive increase in food prices, thereby raising the value of farmland and the value of securing land for food production to insure against the next food crisis. Although the benefits of cultivating vacant land today remain small, increased uncertainty in the wake of the crisis may have led private investors to raise their estimates of the potential future profitability of optioning such land through sales or leases (Collier and Venables 2012).

Figure 6.1.1 shows the sharp increase in the annual number of land deals in the years leading up to the food crisis of 2007–08. In 2009, at the height of the rush for land, a land deal was negotiated almost every single day that averaged 223 square miles in size, which is an area more than five times the size of Paris. As shown in the figure, the appetite for farmland by investors and governments quickly receded in the years following the crisis.

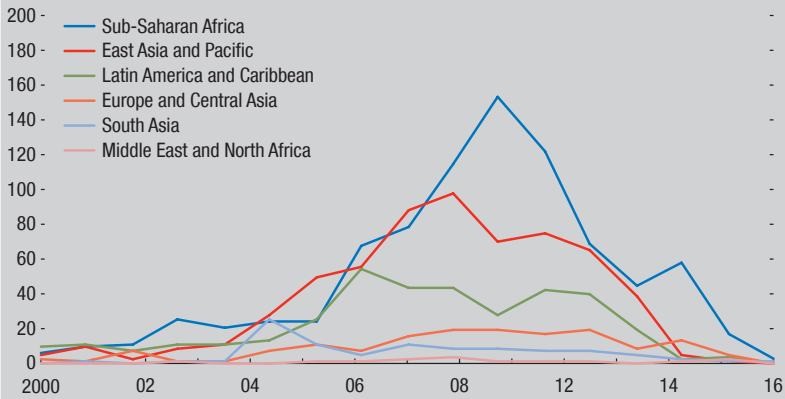
As of June 2016, the Land Matrix database has information on 2,152 transnational deals, the vast majority, or 76.5 percent, of which are linked to agricultural projects, with a cumulative size of almost 59 million hectares in 88 countries. This expanse corresponds to an area roughly the size of France or Ukraine. This is substantial but still fairly modest compared to the total stock of uncultivated and nonforest suitable land, which amounts to roughly 400 million hectares—1 billion hectares when forest land is included. Sub-Saharan Africa (884 deals) and East Asia (611 deals) have been the most important target regions for investment, followed by Latin America (368 deals).

The boom-bust pattern shown in Figure 6.1.1 is consistent with the idea that farmland (option) values are rapidly changing, fueled by substantial shifts in food prices and by uncertainty. Evidence suggests that much of the acquired land has been left idle, raising concerns about the motive behind these large-scale land investments, or hinting at potential obstacles to bringing such agricultural projects to fruition. According to the Land Matrix database, only 49 percent of the land acquired in these deals has been cultivated to some extent, and this fraction is significantly smaller in sub-Saharan Africa (37 percent).

[9]The analysis presented in this box focuses on cross-border deals only.

Box 6.1. A Global Rush for Land (*continued*)

Figure 6.1.1. Evolution of Deals over Time by Target Region
(Number of deals)



Sources: Land Matrix; and IMF staff calculations.

What Do the Data Tell Us?

To explore the determinants of interest in transnational farmland deals, this analysis uses a bilateral Poisson regression to model the occurrence and count of projects in origin-destination pairs. Let N_{ij} be the expected number of projects undertaken in host country *j* by investors from country *i*. The regression pools all land deals between 2000–16.

Following the standard gravity model from the trade literature, land investment is attributed to origin and destination country characteristics, $VarOrig_i$ and $VarDest_j$ respectively, and bilateral variables, $VarBilat_{ij}$. The baseline specification is then as follows:

$$N_{ij} = c + \alpha_i \cdot VarOrig_i + \beta_j \cdot VarDest_j + \gamma_{ij} \cdot VarBilat_{ij} + \varepsilon_i \qquad (6.1.1)$$

in which α_i, β_j and γ_{ij} are the parameters of interest, and ε_i is an error term. With a large number of zeros in the data, the ordinary least square estimator may be biased and inconsistent. To overcome this issue, a Poisson pseudo-maximum likelihood estimator is used (Silva and Tenreyro 2006).

The analysis uses a novel measure of uncultivated, nonforest land that takes into account proximity to market. Data are obtained from the Food and Agriculture Organization's *Global Agro-Ecological Zones* (FAO 2016). To analyze the relationship between this type of foreign direct investment and governance, data on law and order from the *International Country Risk Guide* (The PRS Group 2009), a measure of investor protection from the World Bank's *Doing Business* dataset, and an index of tenure security (de Crombrugghe and others 2009) are included. Physical distance and dummy variables for common language and a former colonial relationship are included as a proxy for trade costs. Finally, an index of food security from the Economist Intelligence Unit is included.

Box 6.1. A Global Rush for Land (*continued*)

The results of our regressions based on equation 6.1.1 are presented in Table 6.1.1. They confirm the importance of trade costs and an abundant supply of uncultivated arable land. Interestingly, and in contrast to the existing literature on capital flows, poor land governance is associated with more land deals (see column (1). As weak land governance and food insecurity are highly correlated (with a correlation coefficient of $\rho = 0.77$), this finding suggests that food-insecure regions are associated with more land investment. Governments of food-insecure countries, while eager to host large-scale land investments, often face the challenge of ensuring that such outside investments actually help alleviate domestic hunger. This is especially difficult in light of weak land governance.

What Are the Implications for Food Security?

Land deals may have either positive or negative effects. On one hand, these deals signal that capital in the agricultural sector is flowing from rich to poor countries and hence help transfer new technology and agronomic knowledge to local farmers. On the other hand, the clustering of these deals in food-insecure countries can potentially amplify the detrimental effects of a future food crisis. Host country governments can remedy these risks by investing in monitoring capacity to ensure that land is leased to investors who (1) promote integration of local producers into value chains; (2) co-invest in local public goods; and (3) compensate displaced land users.

TABLE 6.1.1.

Impact of Land Governance and Food Security on Land Deals

	(1)	(2)
Bilateral Variables		
Distance (log)	−0.838***	−1.061***
	(0.0669)	(0.0793)
Former Colonial Relationship	1.529***	0.874***
	(0.269)	(0.253)
Origin Country Variables		
Net Food Exports (over GDP)	8.199***	
	(1.180)	
Food Security Index		0.0403***
		(0.00447)
Destination Country Variables		
Landlocked	0.234	0.0575
	(0.220)	(0.192)
Suitable Nonforest Land	0.525***	0.810***
	(0.0748)	(0.0936)
Land Governance	−0.572***	−0.165
	(0.0957)	(0.108)
Law and Order	−0.265***	−0.152
	(0.0827)	(0.0958)
Weak Investor Protection	−0.00606**	−0.00913***
	(0.00243)	(0.00256)
Net Food Exports (over GDP)	5.757***	
	(1.384)	
Food Security Index		−0.0539***
		(0.00639)
Observations	19,186	10,044
Pseudo *R*-Squared	0,217	0,283

Source: IMF staff calculations.
Robust standard errors are in parentheses.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

WHAT ARE THE RISKS?

Indian economist Amartya Sen (Sen 1981) first highlighted the fact that hunger was not necessarily the result of a lack of food but a lack of the capability to buy food. Food security is a multidimensional concept. The Food and Agriculture Organization of the United Nations (FAO) (2015) concludes that food security rests on four pillars : (1) availability—the supply side, determined by production, stocks, and trade in food; (2) access—encompassing economic access, or the ability to purchase with one's disposable income, and physical access, the ability to reach food sources via transport infrastructure; (3) utilization—through diet diversity, intra-household distribution of food, and food preparation and consumption; and (4) stability—the constancy of the other three dimensions over time.

Because rapid urbanization and galloping population growth—especially in sub-Saharan Africa and Asia—have not been matched by commensurate increases in domestic food supply, there has been a growing dependency on imports in many countries (Table 6.4). In fact, an overwhelming majority of countries around the world are net importers of food (Table 6.5). Of course, some countries have always been food importers, but between 1990 and 2013 some 27 countries switched from being net food exporters to being net food importers. Nearly all of these countries are from sub-Saharan Africa, Latin America, and east Asia. The list includes Honduras, Vietnam, the Philippines, and Zimbabwe—all of which experienced major drops in net food exports of over 7 percentage points of GDP.

The high concentration of net food importers has led to further concerns about food security. Countries can achieve food security through imports, but whereas economically prosperous countries can easily finance such food imports, impoverished countries struggle to do so.[10] In Over the past few years, prices for most commodities have cratered, but food prices have not. This has rendered

TABLE 6.4.

Urban Population by Region
(Percent of total population)

Region	1990	2014	2050	Change 1990–2014	Change 1990–2050
Africa	31.3	40.0	55.9	8.7	24.7
Asia	32.3	47.5	64.2	15.3	31.9
Europe	70.0	73.4	82.0	3.5	12.0
Latin America and the Caribbean	70.5	79.5	86.2	9.0	15.7
North America	75.4	81.5	87.4	6.0	12.0
Oceania	70.7	70.8	73.5	0.1	2.8

Sources: United Nations, *World Urbanization Prospects*: *The 2014 Revision*; and IMF staff calculations.
Note: Oceania includes American Samoa, Australia, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia, Nauru, New Caledonia, New Zealand, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, and Wallis and Futuna Islands.

[10]The poorest population segments of some prosperous countries may also be subject to food insecurity.

TABLE 6.5.

Net Food Exports
(1990 versus 2013, number of countries)

Region	Always Exporter	Always Importer	Exporter → Importer	Importer → Exporter	Total
East Asia and Pacific	6	17	7	2	32
Europe and Central Asia	9	13	1	1	24
Latin America and Caribbean	12	14	8	0	34
Middle East and North Africa	0	17	2	0	19
North America	2	1	0	0	3
South Asia	1	6	0	1	8
Sub-Saharan Africa	4	29	9	3	45
Total	34	97	27	7	165

Sources: Food and Agriculture Organization of the United Nations; World Bank, *World Development Indicators*; and IMF staff calculations.

many developing economies—many of which are commodity exporters—more exposed to food price shocks by reducing their export receipts and putting increased demands on their overall budgets.[11]

Climate change affects agricultural production through economic losses resulting from reduced crop yields and livestock productivity, changing average temperatures and patterns of precipitation, and extreme weather events such as heat waves and severe storms. There are a host of other effects, too, including changes in pests, diseases, and atmospheric concentrations of carbon dioxide (Porter and others 2014). Generally, countries closer to the equator will be more vulnerable to the adverse effects of climate change than countries at higher latitudes (Rosenzweig and others 2014).[12] For example, Ethiopia recently experienced the most severe drought in decades in association with the 2015–16 El Niño weather phenomenon. Rainfall during Ethiopia's two main rainy seasons directly affects more than 80 percent of the country's agricultural yield and the more than 85 percent of the population engaged in agricultural production. The recent drought therefore caused a massive spike in humanitarian needs over several years (Government of Ethiopia 2015).[13]

Such extreme weather events and the resulting threats to food security are expected to worsen and increase in frequency (International Food Policy Research

[11]In principle, food terms of trade shocks can also lead a country to switch from being a food exporter to a food importer. In practice, fast population growth and urbanization, stagnating productivity, and poor infrastructure are key elements explaining many developing economies' dependence on food imports (Rakotoarisoa, Iafrate, and Paschali 2011).

[12]There is evidence to suggest that climate change affects different crops differently.

[13]Beyond Africa, the impact of the 2015–16 El Niño in Asia was even more severe in certain locations such as the uplands of Cambodia, central and southern India, eastern Indonesia, central and southern Philippines, central and northeast Thailand, Papua New Guinea, and other Pacific island countries. In India, severe floods were already been reported in several parts of Tamil Nadu during November and December 2015, and inundated inundating most areas of Chennai (UNEP 2015).

Institute 2016; UNEP 2016; and World Bank 2015a).[14] So-called climate-smart agriculture (CSA) can help mitigate the effects of climate change on agriculture by creating opportunities for smallholder farmers to sustainably and efficiently produce more nutritious crops (IFPRI 2016).[15] CSA is an integrative approach with three objectives:

TABLE 6.6.

Share of Food and Beverages in Total Consumption, 2010 (Percent)

Area	Share
High-Income Countries	21.0
Middle-Income Countries	43.7
Low-Income Countries	56.6
Guinea	71.1
Burundi	71.0
Dem. Rep. of Congo	69.5

Sources: World Bank, Global Consumption Database; Organisation for Economic Co-operation and Development, National Accounts database; and IMF staff calculations.
Note: Includes processed food such as alcoholic beverages and catering services.

To sustainably increase agricultural productivity in order to support equitable increases in farm incomes, food security and development; to adapt and build the resilience of agricultural and food security systems to climate change at multiple levels; and to reduce greenhouse gas emissions from agriculture (including crops, livestock and fisheries).

The FAO and the U.S. Agency for International Development (USAID) have established early warning systems to anticipate and prevent famines. The FAO hosts the Global Information and Early Warning System, which monitors the world food situation in 190 FAO member states and provides early warnings of impending crises (Groskopf 2016). The Famine Early Warning Systems Network (www.fews.net) set up by USAID helps anticipate and plan for humanitarian crises in 29 countries.

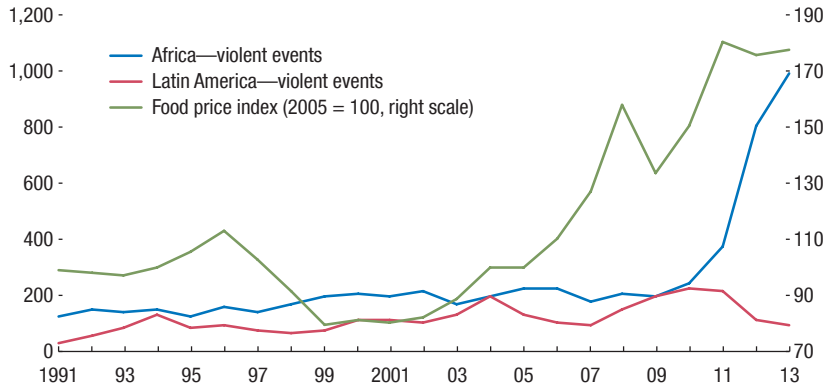
Volatility in food prices or outright food shortages have a crucial impact on the most basic aspect of welfare in poor countries, namely, survival. As shown in Table 6.6, the share of food and beverage consumption in the overall consumption basket is dramatically high for many low-income countries. It is even higher for fragile states, including Guinea and Burundi. For middle-income countries, the share is somewhat lower but still significant—approaching 50 percent of total consumption. Existing econometric evidence (Arezki and Brueckner 2014; and Bellemare 2015) suggests that food price volatility can cause enormous distributional challenges within and between countries and can lead to conflicts (Figure 6.5).[16] Existing indices (Figure 6.6) show that, as a region, Africa is the

[14]In Latin America and southeast Asia, floods and droughts during recent El Niño/La Niña episodes, which already cause heavy losses in agriculture, are likely to double in frequency (World Bank 2015b).

[15]For example, C4 rice has been found to increase yields by 50 percent as a result of doubling water use efficiency and increasing nitrogen use efficiency by 30 percent.

[16]Food production is endogenous to civil conflict: country examples are indicative that the presence of civil war may be associated with an increase is domestic food prices. For example, in

Figure 6.5. Food Prices and Violent Events
(Number of events, unless noted otherwise)



Sources: IMF, Primary Commodity Price System; Social Conflict Analysis Database 3.1; and IMF staff calculations.

most prone to such food insecurity, but pockets of vulnerability also exist in Asia, Central America, and South America.

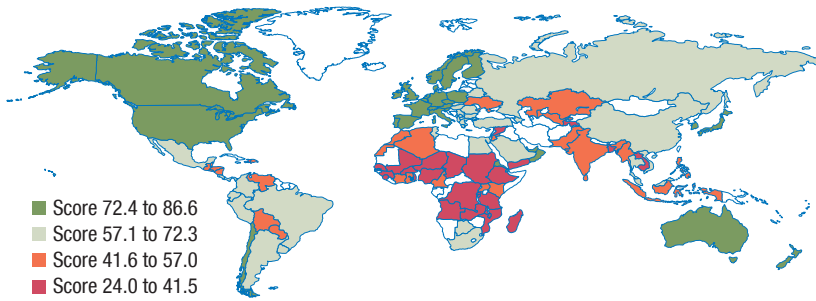
Policy interventions can serve to amplify food price spikes. The price volatility of weather-dependent commodities like food is exacerbated by the tendency for both advanced and emerging and developing economies to alter their trade and domestic policies from year to year in an effort to stabilize prices and supplies in domestic food markets (Anderson 2016; FAO 2015). During periods of elevated food prices, as during 2007–08, net food exporting countries frequently implement export restrictions whereas net food importers lower import barriers, both in an attempt to increase domestic food supplies. Taken together, these two policy responses amplify the food price spike (Anderson, Rausser, and Swinnen 2013; Anderson 2016). An effective means of preventing such outcomes, as demonstrated in developing Asia, is to raise agricultural sector productivity and improve supply chains, as well as to promote regional coordination—including through maintaining and managing regional grain reserves (Jha and Rhee 2012).[17]

Overall, food markets are segmented due to distortions in trade and domestic impediments to investment in the agricultural sector. Demand for food has and will continue to grow at a rapid pace as a result of global population growth.

Darfur, Sudan, prices of the main food staples increased rapidly after widespread violence started in late 2003 and early 2004 (see for example Brinkman and Hendrix 2010).

[17]There are other means to alleviate food shortages, including: reducing excessive food consumption, which leads to obesity and associated negative health outcomes; and reducing food waste. The FAO estimates that one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons a year.

Figure 6.6. Global Food Security Index, 2016
(Overall score 0–100; 100 = best environment)



Source: Economist Intelligence Unit, Global Food Security Index 2016 Workbook.

Income growth also affects the composition of food demand. Accelerated urbanization trends in Africa and Asia will make even more countries dependent on trade to meet their domestic requirements. To meet these challenges and reduce food insecurity, advanced economies, emerging markets, and developing countries will need to continue to reduce barriers to trade. Low-income countries should also raise productivity in their agricultural sectors by attracting capital flows, but for that to occur, multifaceted institutional improvements are needed.

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