Part IV

National and Regional Responses to Food Price Volatility

India's Food Security Policies in the Wake of Global Food Price Volatility

14

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Abbreviations

APMC	Agricultural Produce Market Committee
BE	Budget estimates
C&F	Cost and freight
CACP	Commission for Agricultural Costs and Prices
CAGR/CARG	Compound annual growth rate/compound annual rate of growth
CAP	Cover and plinth
CCI	Cotton Corporation of India
CIF	Cost insurance and freight
CoP	Cost of production
CSO	Central Statistics Office
CV	Coefficient of variation
DAC	Department of Agriculture and Cooperation
DARE	Department of Agricultural Research and Education
DES	Directorate of Economics and Statistics
DFPD	Department of Food and Public Distribution
DGCIS	Directorate General of Commercial Intelligence and Statistics
DGFT	Directorate General of Foreign Trade
ECA	Essential Commodities Act, 1955

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F&V	Fruits and vegetables
FAO	Food and Agriculture Organization
FAQ	Fair average quality
FCI	Food Corporation of India
FFPI	FAO Food Price Index
FOB	Free on board
FY	Financial year
GCF	Gross capital formation
GDP	Gross domestic product
KMS	Kharif marketing season
MEP	Minimum export price
MSP	Minimum support price
MSR	Marketed surplus ratio
MMT	Million metric tonnes
NFSM	National food security mission
NWRs	Negotiable warehouse receipts
OGL	Open general license
OMSS	Open market sale scheme
OWSs	Other welfare schemes
PDS	Public distribution system
PMEAC	Prime Minister's Economic Advisory Council
PSS	Price support scheme
Qtl	Quintal
SEZs	Special Economic Zones
STC	State Trading Corporation
TE	Triennium ending
TFP	Total factor productivity
TRQ	Tariff rate quota
USDA	United States Department of Agriculture
WDRA	Warehousing Development and Regulatory Authority
WTO	World Trade Organization

14.1 Backdrop

In a country which has a population of 1.25 billion and which still has the largest number of poor and malnourished people in the world, ensuring food security for the masses is one of the prime concerns of the government policy.

It may be worth noting that an average Indian household still spends about 45 % of its total expenditure on food (NSSO 2013). The decade of the 2000s saw the overall GDP grow by an average annual growth rate of more than 7 %. With population growing by less than 1.5 % per annum, per capita incomes consequently rose by more than 5.5 % per annum, thus exerting pressure on food demand, and the pressure is only going to amplify in the foreseeable times. If India can raise its domestic food production at a pace faster than its domestic demand, it can at least

have food available to feed its population from domestic sources. Otherwise, India would have to increasingly rely on food imports.

India is already importing more than half of its edible oil consumption and about 15–20 % of pulse consumption from global markets. Any abrupt increase in the global prices of these commodities will therefore directly affect their domestic prices and consumption and thereby elements of food security. Domestic prices of important food commodities are also affected when the commodities are exported. India, for example, has been the largest exporter of rice from financial year (FY) 2011–2012 to 2014–2015, and its domestic prices are affected by what is happening in the global rice market.

Against this backdrop, this paper looks at the issue of food security in India in the wake of recent global food price volatility, especially the price spikes of 2007–2008 and the price surge in early 2011, when global food price index exceeded the previous peak from 2008. How did India react to global food price spikes of 2007–2008? Could it protect its poor? What were the likely implications of India's policy choices on global prices? What lessons can we learn from that experience in terms of providing reasonable stability in food prices, locally and globally, so that food security can be ensured for the masses? These are some of the questions that will be addressed in this paper.

The paper is organized as follows: In Sect. 14.2, we study the global rice and wheat markets and how India is placed in it. Section 14.3 elaborates on the policy landscape of rice and wheat, the two primary staples in India. The section is subdivided into two parts where both the trade and the domestic policies are given. After elaborating on India's policy response to the global food crisis of 2007–2008, we use the interconnectedness of the global and the domestic food prices to illustrate India's competitiveness in the global markets. The subsection about domestic grain policies highlights the domestic grain dynamics and the major policy changes in the domain. The last section encapsulates the things that could be learned from the analysis in this paper and gives suggestions for the future with regard to the Indian grain trade market.

14.2 Global Rice and Wheat Markets and India

Only 9 % of the total rice production was globally traded between 2013 and 2014 (see Figs. 14.1 and 14.2). This indicates a rather thin global rice market compared to wheat and corn, where 23 % and 13 % of the production was traded respectively. The rice supply in global markets is also highly concentrated: in 2013–2014, 80.4 % of the global rice supply came from five countries, namely, Thailand, Vietnam, the United States, Pakistan, and India.

Globally, the production of all three staples is going up. The markets are expanding and so are the demands. Between 2011–2012 and 2013–2014, global exports of rice, wheat, and corn increased by 9 %, 5.4 %, and 24.9 %, respectively. This increase may also be due to the markets liberalizing after the 2007–2008 global food crisis, in which the major food exporters like India and Thailand restricted

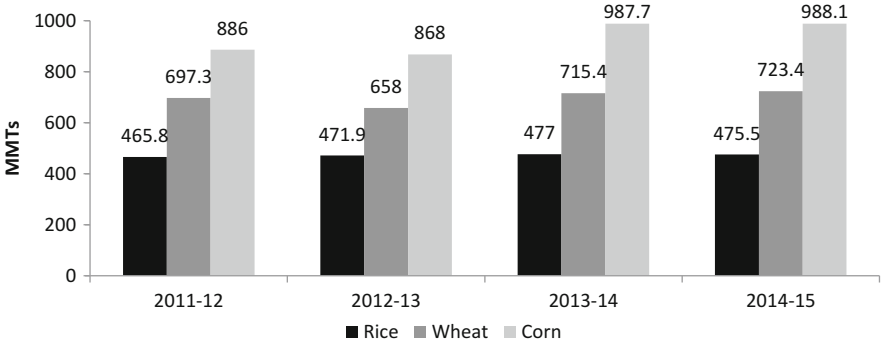

Fig. 14.1 Global production trend of the three staples—rice, wheat, and corn since FY 2011–2012. *Source*: USDA

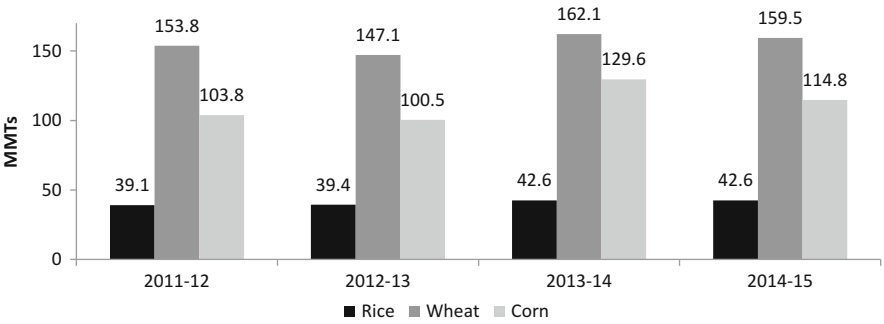

Fig. 14.2 Trends in world exports (MMT). *Source*: USDA

their food supplies and thus triggering an unprecedented global food price spike in history.

As a net food exporter, India was bound to benefit from such global trend. We next examine the performance of the Indian agriculture exports.

India exported more than US $42.6 billion worth of agricultural exports in 2013–2014, while it imported agricultural commodities worth US $15.9 billion; India's agriculture trade account had therefore a net surplus (Fig. 14.3). According to the WTO, India's share in the total global export of agricultural products increased from 0.8 % in 1990 to 2.6 % in 2012. India emerged as the world's largest exporter of rice.

India has a gross cropped area between 190 and 200 million ha, depending upon the amount of rainfall during the monsoons. In 2013–2014, India produced about 106 million metric tonnes (MMTs) of rice from roughly 43 million ha (m ha) of rice planting area and 96 MMT of wheat from 29 m ha of wheat planting area. India's share of rice and wheat production globally is roughly 22 % and 13 %, respectively (FAO, stat).

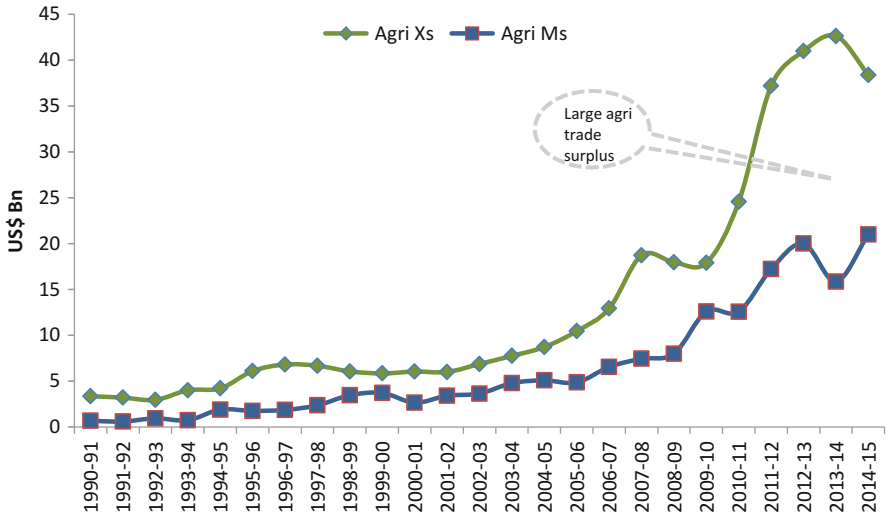

Fig. 14.3 India's exports and imports of agricultural commodities. *Source*: Agricultural Statistics at a glance (various issues) and the Department of Commerce. *Note*: Figures for 2014–2015 are estimates

Rice and wheat are staple crops of the country and help in meeting a significant proportion of the daily caloric needs of the people. Close to 22 % of the population still live below the poverty line, as estimated by the Planning Commission based on Tendulkar poverty line (Planning Commission 2014). By international definition of US $1.9/day/capita, almost 21.3 % of the people in India lived below poverty line in 2011 (World Bank 2014). The largest mass of poor and malnourished people in the world live here (World Bank 2013). Roughly about one-sixth of the world's people and one-third of the world's poor are Indians. One in every three malnourished children in the world is from India (HUNGaMA 2011). Thus, anything affecting food prices, and rice and wheat in particular, is important for Indians, especially for those hovering around the poverty line. It is no wonder that the government monitors food prices very closely.

The Indian government supports both the cereal producers as well as its consumers. By providing price support mechanisms for paddy and wheat using minimum support price (MSP) and by reducing their effective costs of production (input subsidies mainly for fertilizers, electricity, and irrigation), the government supports and incentivizes cereal (rice and wheat) production. The government also supports the consumers by ensuring that prices of wheat and rice remain low and stable through its public distribution system (PDS). It provides identified beneficiaries with subsidized (and sometimes free) food under its various food-based welfare schemes. The government also utilizes the Open Market Sale Scheme Domestic (OMSS-D) to smoothen any inter-/intra-year fluctuations by actively regulating the market grain supply and thereby ensuring price stability.

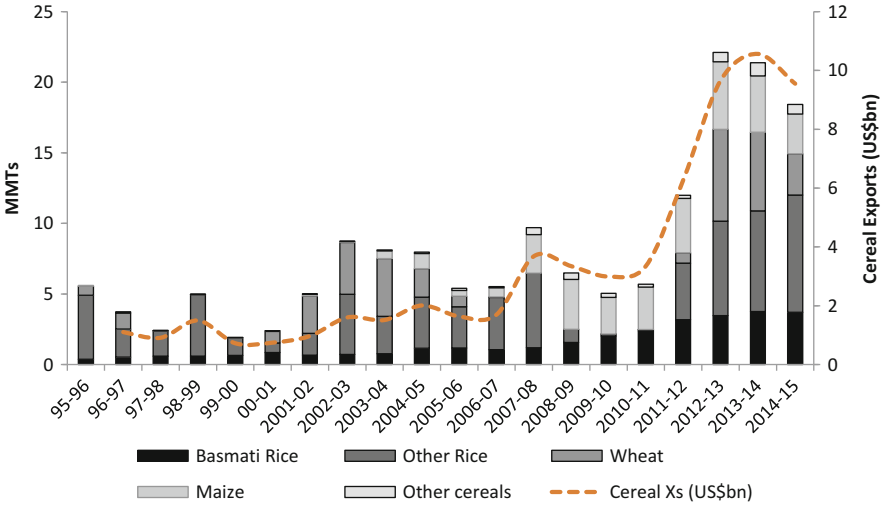

Fig. 14.4 Trends in cereal exports quantity and values. *Source*: DGCI&S

India is a net exporter of agricultural commodities, whereas it is a net importer in the overall trade (CACP, Kharif Report 2013–2014). Both in terms of quality and cost, Indian rice has a comparative advantage in the global market. Nevertheless, India's agricultural trade policies are somewhat conservative and subject to frequent bans/restrictions. Nevertheless, in the last 3 years since FY 2012–2013, India exported a total of approximately 62 MMTs of cereals, and around 53 % (i.e., 33 MMTs) of this consisted of rice exports. The country earned close to US $30 billion from these cereal exports (Fig. 14.4).

What could explain such a massive increase in cereal exports? Open trade policy regime (more recently for common rice), overflowing government granaries owing to production gains, and global price (cost) competitiveness could explain the phenomenon. We will look at the factors individually.

14.3 Rice and Wheat Policy: Trade and Domestic

Historically, India has been a country of droughts and famines. It is an agrarian economy with large dependence on rains for irrigating its crops. 54 % of its gross cropped area and 40 % of the rice planting area are still rainfed. With close to 1.25 billion people to feed, including the highest number of the global poor, opening the trade of its staple crops, like rice, is still a decision to be made with extreme caution. A significant proportion of the Indian population is still rice eating. Because of growing concerns regarding the high level of malnutrition and food security issues in the country, the government has always been cautious in liberalizing the rice and wheat trade. Therefore, the government has always first met the consumption needs and maintained *enough* buffer stocking before letting the "residual" determine the nature of trade policy.

India has come a long way since the mid-1960s, when it was living from "ship to mouth" through PL 480 imports from the USA to today when it has become the largest rice exporter globally and a net agricultural exporter. Still India's rice and wheat trade policy is highly cautious and sometimes even unpredictable as we will see in the section below.

14.3.1 Grain Policy: Trade

India exports mainly two types of rice: basmati and common rice (raw or par boiled). While the former is a finer quality rice meant for niche markets in the Gulf, Europe, and the USA, the latter is comparable to the type of rice supplied by Thailand, Vietnam, and others. India's trade policies for both types of rice are different from each other. While there has been no restriction on the export of basmati rice, trade restrictions, such as minimum export price (MEP), export quotas, and even complete bans, have been imposed on the common rice export. Until 1991, the common rice export was completely restricted; with quotas and MEP in place. Overvalued exchange rate and export restrictions taxed the Indian farm sector before 1991. The devaluation of the Indian rupee in 1991 contributed immensely to making the expensive basmati rice more price competitive in the global market, and thus its export surged.

Common rice exports were banned until October 1994 despite being highly price competitive globally. The government finally decided to open common rice exports in FY 1995–1996. As a result, the net exports of the common rice surged from 0.9 MMTs in 1994–1995 to 4.9 MMTs in 1995–1996 (Fig. 14.5), making India the second largest exporter of rice in the world. Encouraged by the phenomenal growth in rice exports, India opened its wheat exports in May 1995. However, increasing exports squeezed domestic market supplies thus building pressures on the domestic prices. Within a year, the rising prices of staple crops like rice and wheat drove the policymakers to reverse the trade decision and completely ban the rice and wheat exports in 1996–1997 (Hoda and Gulati 2008).

Increased production incentivized by rising minimum support prices (MSPs), falling global grain prices owing to many factors like the 1997 East Asian crisis, falling PDS grain offtakes due to the "targeted" focus of the system in 1997, and export bans were among the many factors that resulted in the overaccumulation of grain stocks in the coming years in the country. This forced the government to remove the bans on rice and wheat exports in 2000.

But it was not before 2005–2006 when Indian wheat regained its competitiveness because global prices had improved from their trough in around 2001–2002 (Hoda and Gulati 2008). Wheat exports were expected to rise; however, contrary to expectations, the government had to import wheat in 2006 to refill its plummeting wheat stocks in the Food Corporation of India (FCI) granaries. The FY 2006–2007 was an interesting year for the food sector of the country. Owing to farmers (mainly wheat) getting a better price for their produce from the private market, the FCI was unable to meet its annual procurement targets, and thus its granaries fell below the

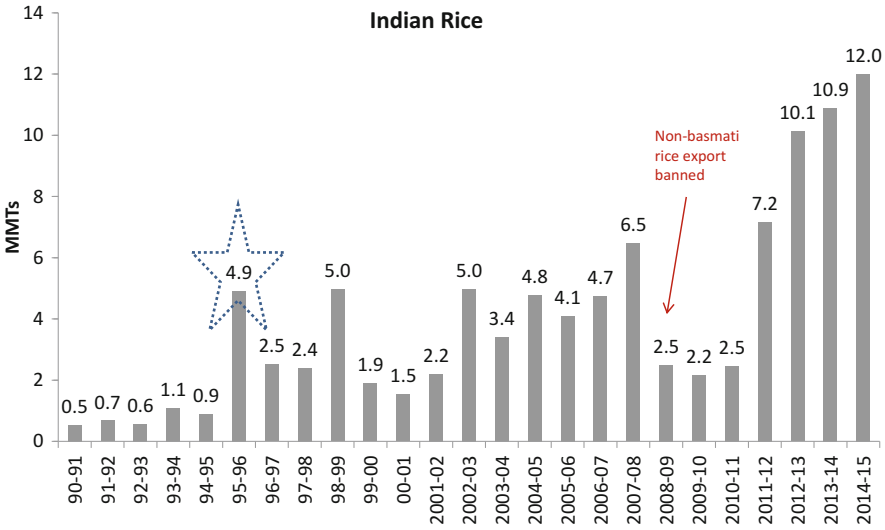

Fig. 14.5 India's exports of rice from 1990–1991 to 2014–2015. *Source*: Ministry of Commerce, GoI

desired stock norm level. Consequently, the government imported wheat amounting to 5.6 MMTs in that year. This is when India decided first to ban wheat exports in February 2007 (Sharma 2011).

14.3.2 The 2007–2008 Global Price Hikes and India's Response

From the point of view of Indian policymakers, India's withdrawal from the international rice and wheat markets in 2007 was a well-calibrated response. However, it appeared like a knee-jerk reaction to outsiders. Some of the alarming concerns driving the Indian policymakers' response to the global food crisis included food insecurity at the household level, impacting millions of vulnerable people, continued volatility in agricultural production caused by weather changes, fear of political unrest in times of high and sticky food inflation, and the need to feed a large PDS. In this section, we discuss India's policy response to the crisis, mainly for the rice and wheat markets.

Export Restrictions on Rice To stop the global price hikes from being transmitted to the domestic market and to strengthen the government's grain stocks, the country started imposing export restrictions on common rice. In October 2007, they imposed an MEP on common rice of US $425/ton; but by December 2007, this MEP was increased to $500/ton. Nevertheless, the exports of rice continued unabated. In March 2008, the government finally imposed a complete ban on common rice exports. The exports of rice dropped from 6.5 MMT in 2007–2008 to only 2.5

MMT in 2008–2009 (and these were mainly basmati rice exports). This decision to ban exports of common rice in the wake of surging global prices came under severe criticism from several rice-importing countries. In response, India opened a window to export common rice at "concessional" prices compared to prevailing global prices of rice to some neighboring countries, like Bangladesh and Bhutan, and also to some low-income African countries. However, not much rice was actually exported. The government eventually lifted the export ban on common rice in September 2011. Since then, India has exported record quantities of rice, especially in 2014–2015, when 12 MMT of rice was exported (Fig. 14.5).

The share of common rice in the total rice export earnings increased from 4 % in 2010–2011 to 42.6 % in 2 years. During the period in which the export ban on common rice was in place, India's basmati rice exports constituted 2.5 % (2008–2009) and 2.4 % (2009–2010) of the total rice production in India. Today, after the ban has been removed, the country is exporting close to 10 % of its annual production (Fig. 14.6).

The 1990–1991 Indian rice export basket comprised mainly basmati rice. With the opening of the common rice trade, the share of basmati rice exports in the total rice export decreased over time to less than 35 % in 2012–2013.

India has emerged as the world's largest rice exporter since 2011, closely competing with Thailand. Despite the export competiveness, the country imposes, contrary to expectations, high import duty on rice: −70 % on semi-milled or wholly milled rice and 80 % on paddy, brown rice, and broken rice. Such a high import duty is ineffective when the country is quite export competitive in rice and has been exporting more than 10 MMT of rice annually since 2012–2013.

Export Restrictions on Wheat India is the world's second largest wheat producer after China, producing about 12 % of the global wheat. It has, however, not been

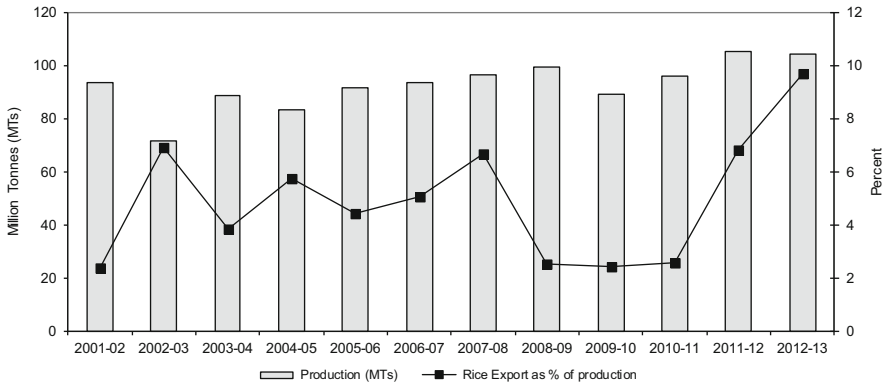

Fig. 14.6 India's exports as a percentage of rice production. *Source*: Agricultural Statistics at a Glance, Various Issues

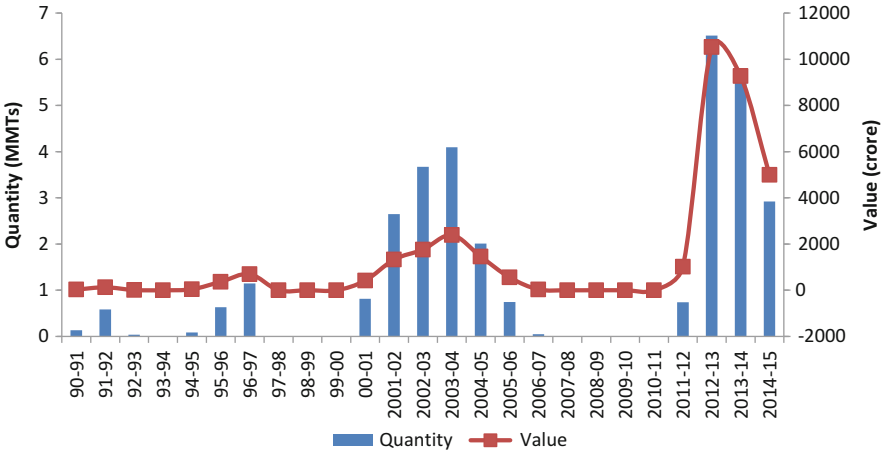

Fig. 14.7 India's exports of wheat from 1990–1991 to 2013–2014. *Source*: Ministry of Commerce, GoI

among the largest wheat exporters (accounting for about 3 % of total world exports) because the country consumes more than 90 % of its production, and it even had to import wheat in some of years (India was the fourth largest importer of wheat in 2006–2007). India imposed a complete ban on wheat exports in February 2007 (Fig. 14.7) in reaction to rising prices and supply fears, both domestically and globally.

Since India has a very small share in the global wheat market, its restrictions on wheat exports did not have any significant effect on international prices. But the imposition of the ban pulled domestic prices of wheat down from US $283/ton in February to US $225/ton by April (Fig. 14.8).

The export ban also helped the domestic market to remain stable and insulated from the steep hike in international prices in the first half of 2008; in April 2008, when the wheat price in the global market touched US $380/MT, the domestic wheat price in India was less than US $280/MT (Fig. 14.8).

14.3.3 Impact of Global Prices on Domestic Prices

In 2006–2007, as mentioned before, India imported about 6 MMTs of wheat after a long time. When the global prices of rice and wheat increased drastically in 2007–2008, banning the rice and wheat exports seemed to be a logical response in the country's efforts to insulate its poor from global prices spikes getting transmitted to the domestic markets. As a result, India was actually able to contain its domestic cereal inflation to about 6 % in 2007–2008, which helped restrict the overall food inflation at the time and thus *protect* India's poor from the price volatility. Similarly, India managed to avoid the more severe price spikes of 2010–2011, when

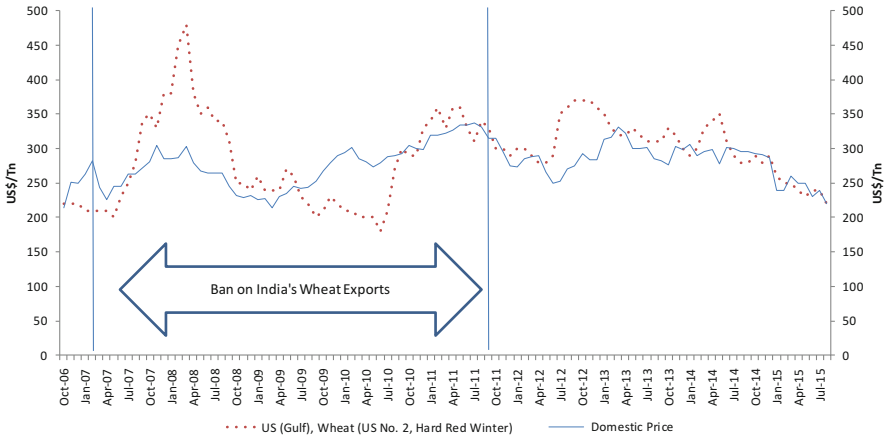

Fig. 14.8 Trend in India's domestic and international wheat prices. *Source*: International price (USA, Gulf, No. 2 Hard Red Winter): GIEWS Food price data and analysis tool. Domestic price (avg monthly data of HYV wheat—wholesale prices in Lucknow, UP and Amritsar, Punjab): DoE

in February 2011 the global food price index even exceeded the peak reached in 2008. However, what happened in the long run is an interesting departure from expectations.

A closer examination of the food price indices of the country and of the world (Wholesale Price Index (WPI) food and FAO food, respectively) reveals that the *protection* was only effective in the short run as the two price indices appear to have converged over the longer run, thus rejecting the *transmission insulation* theory.

Since the period between 2004 and 2013, the correlation between FAO food and Indian WPI food has been 0.78, indicating strong comovement between the indices. Figure 14.9 shows that India's restrictive stance on trade policy has in fact helped the country to escape the food price spikes of the food crisis of 2007–2008 and 2010–2011. However, in the longer run, the domestic price line appears to be converging with its global counterpart.

Clearly, India managed to avoid price spikes in its domestic market. Interestingly, the country also managed to avoid the troughs in global markets. In other words, it did not allow falling global prices to immediately get transmitted to its domestic prices. For the years 2000–2005 and more recently since 2013, when the global food prices fell, Indian food prices remained somewhat higher. It is possible that the domestic prices will converge over a longer period. The upshot is that Indian trade policy has tried to smoothen out the effects of global price spikes and troughs to prevent volatility transmission to the domestic prices, but in the medium to long term, Indian food prices have broadly followed the global food prices.

The FAO Food Price Index is a measure of the monthly change in international prices of a basket of food commodities. It consists of the average of five commodity group price indices, weighted with the average export shares of each of the groups for 2002–2004. The commodity groups are sugar, dairy, meat, edible oils, and

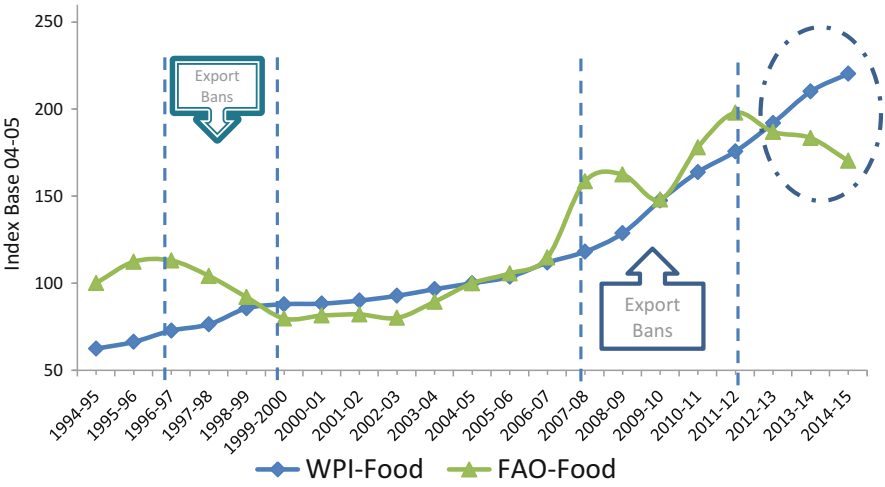

Fig. 14.9 Global price transmission to Indian prices. *Source*: FAO and CSO

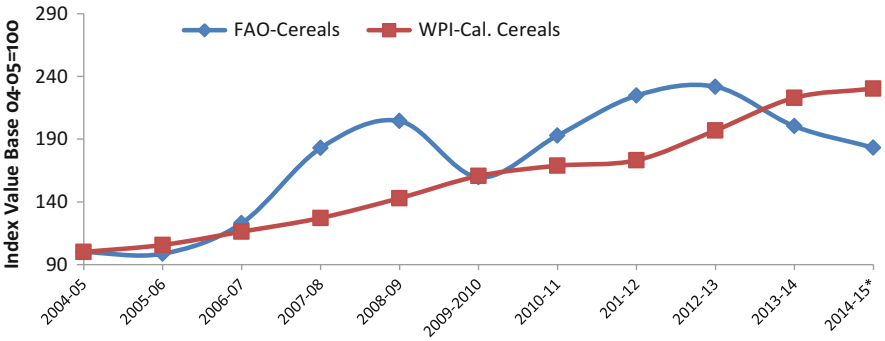

Fig. 14.10 Cereal price comovements. *Source*: FAO and CSO

cereals. Upon bringing the base of all these groups from 2002–2004 to 2004–2005, we analyzed the numbers together with subindices of India's WPI (Figs. 14.10 and 14.11).

Similarly, the domestic prices appear to be catching up with the international long-run trends. The role of restrictive trade policy is evident here.

Several researchers have proven the non-transmission or limited transmission of global volatility to domestic prices (see, e.g., Pinstrup-Andersen 2015; Kalkuhl 2014). Baltzer (2015) wrote:

> Non-fiscal interventions, such as non-tariff trade barriers, parastatal grain traders (China, India, Vietnam, Ethiopia, Malawi, Zambia and Egypt) and price controls (notably Senegal), disrupt the price transmission mechanisms in ways harder to generalize.

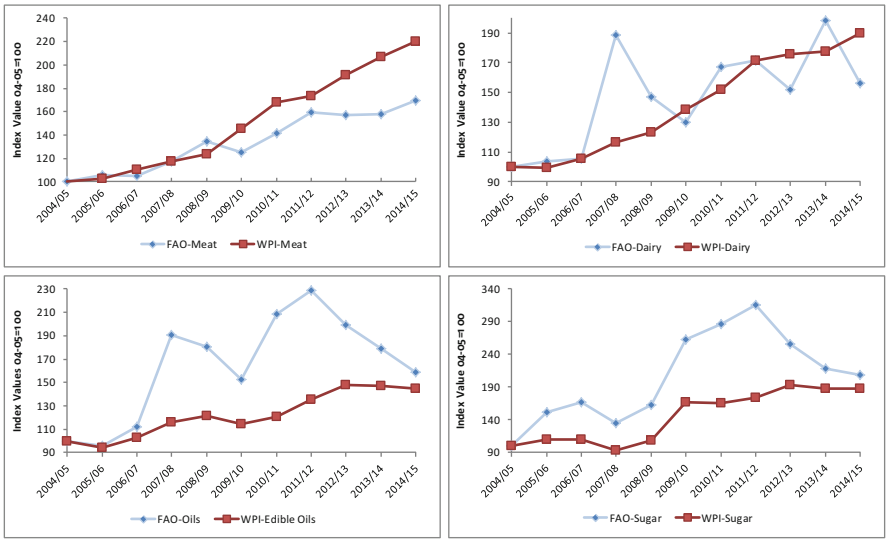

Fig. 14.11 Trends in WPI and FAO price subindices. *Source*: FAO and CSO

India's Economic Survey 2014–2015 attributed the divergence between the global and domestic prices to restrictive domestic food and trade policy. However, the curves shown above highlight the limitations of these opinions—even though these opinions may be true in the short run, but over a longer run, the opinions appear to fall flat with the commoving global and domestic food prices, as evidenced by the converging global and domestic food price curves. More sophisticated, statistical, and econometric tools are needed for a more robust analysis of the phenomenon.

14.3.4 Indian Rice and Wheat Competitiveness

From 2001–2002 to 2007–2008 (Q1), India's domestic wholesale rice prices were generally higher than international prices, but from 2007–2008 (Q2) to 2012–2013 (Q3), they have been continuously lower than the international prices (Fig. 14.12). It may be observed that MSP of paddy converted to rice has been continuously lower than domestic wholesale prices of rice during the same period.

Indian wheat prices, on the other hand, have closely followed the international wheat prices of the US hard red winter (HRW) and the soft red winter (SRW) (*fob*). The 2007 export ban on wheat protected India's domestic wheat prices from the enormous international food price volatility (Fig. 14.13). While the export ban protected consumers from these fluctuations, it also harmed farmer's interests by limiting their exposure to lower domestic prices. Indian wheat prices generally hovered between the *fob* and *cif* wheat prices. With global wheat prices rising in 2007–2009, Indian wheat became highly price competitive. It has regained its price

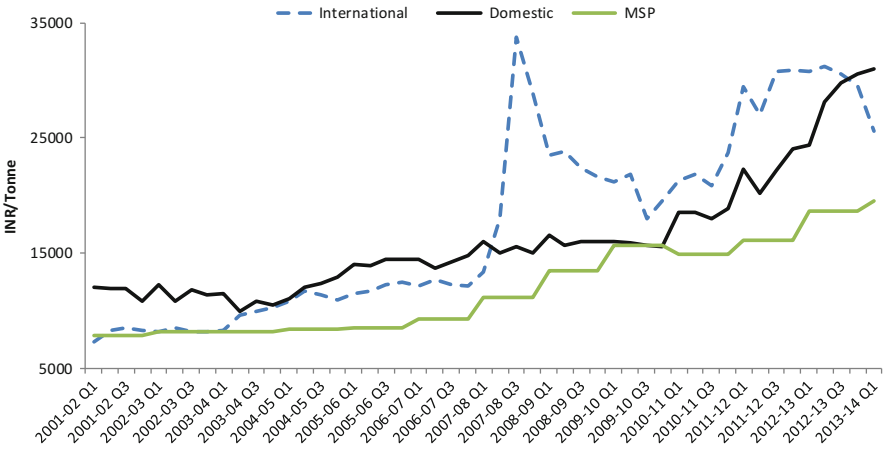

Fig. 14.12 Domestic wholesale prices versus international rice prices. *Source*: World Bank for International prices and DES for Domestic wholesale prices. *Note*: Rice (Thailand), 25 % broken, WR, milled indicative survey price, Government standard, f.o.b. Bangkok. Quarters refer to marketing year (October–September)

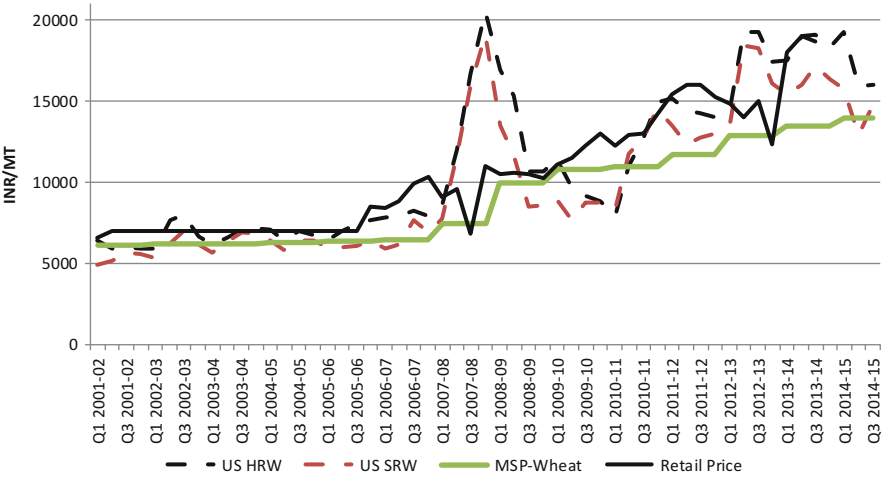

Fig. 14.13 Domestic wholesale prices versus international wheat prices. *Source*: World Bank for International Price and DES for domestic Prices & MSP from CACP Report. *Note*: (1) Wheat (US) No. 1 HRW, export price delivered at US Gulf port for prompt or 30 days Shipment. (2) Wheat (US) No. 2, SRW, export price delivered at US Gulf port for prompt or 30 days Shipment. (3) Domestic prices of wheat are the farm harvest prices in Punjab

competitiveness in 2011, when it opened its wheat exports in September. More than 12 MMTs of wheat were exported in 2012–2013 and 2013–2014.

India's MSP has been fairly lower than most of the other rice and wheat-producing economies (Fig. 14.14). Studies (Gulati et al. 2010) using the nominal

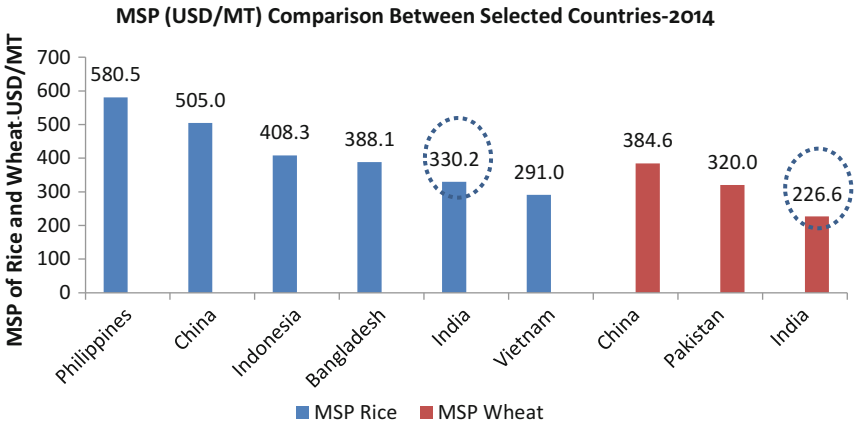

Fig. 14.14 MSP of selected rice- and wheat-exporting countries. *Source*: Links from the respective countries

protection coefficient (NPC) have shown that Indian rice is export competitive, with its domestic prices lower than the global rice prices in most years.

In the next section, we unearth the trends in the domestic production and understand the policy environment governing the rice and wheat farmers and the consumer.

14.3.5 Grain Policy: Domestic

The government intervention in domestic markets of wheat and rice, ranges from providing farmers with price support under MSP, procuring grains from *mandis* (grain wholesale markets) or through millers under compulsory levies on rice, to stocking and distributing the procured grains through the PDS. The reason that government intervention has been heavy in wheat and rice markets is rooted in the country's history of famine and shortage of basic staples. Despite the costs of market intervention, the government is unwilling to withdraw the intervention for fear of risking potential high price volatility, which affects the food security of the vulnerable sections of society. Lately, the new government set up a high-powered committee to look into the functioning of the FCI in this context. The committee made some wide-ranging recommendations, which included abolishing levy on rice, outsourcing grain-stocking operations to private sector, introducing cash transfers in the PDS, and reducing the buffer stocks held by the government. The government has introduced pilot schemes for cash transfers, but many other recommendations are still under consideration.

During the 2007–2008 global price crisis, the Government of India took two major steps: (1) it raised the MSP substantially and (2) it started the NFSM in 2007 to produce additional 20 MMT of grains in the subsequent 5 years.

The MSPs were raised aggressively in the years 2007–2008 and 2008–2009. MSP increases were also necessitated by the country's need to become self-sufficient in cereals' production, which suffered a setback in 2006–2007, when it had to import wheat because FCI grain stocks fell below the norm. The MSP increases formed a pivotal step in the direction of attaining maximum self-sufficiency domestically.

14.3.6 National Food Security Mission 2007–2008

As a response to this forced wheat import in 2006–2007, India launched the NFSM in 2007–2008. The objective of this mission was to increase the country's food grain production by at least 20 MMT in the 5 years after that—rice production by 10 MMT, wheat by 8 MMT, and pulses by 2 MMT. A two-pronged strategy was adopted to boost grain production: (1) introducing better technology (seeds) to the districts/states which were identified as priority, and (2) MSP for wheat and rice were raised by almost 40 % over the next 2 years, thereby encouraging farmers to grow more of food grains. Farmers responded positively to the combination of technology and incentives, and grain production increased by 42 MMT between 2006–2007 and 2011–2012, even though the target was just 20 MMT. This increase in production coincided with a period of export bans on rice and wheat. The unexpected production boom resulted in massive accumulation of grain stocks. The stocks with FCI, for example, reached unprecedented levels of 80.5 MMT on 1 July 2012 (Fig. 14.15).

Increasing MSPs guaranteed the further strengthening of the grain production. Eventually the policymakers opened the exports of wheat and common rice in 2011. Since then India has become the largest rice exporter in the world, regularly

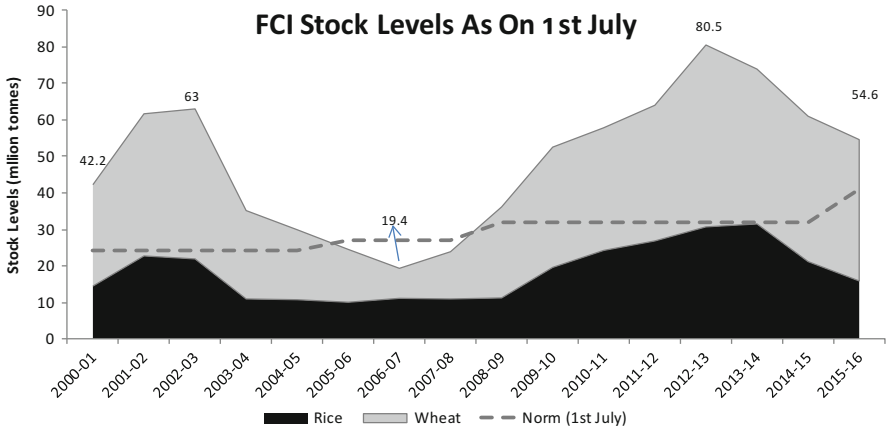

Fig. 14.15 FCI grain (rice and wheat mainly) as of 1st July every FY. *Source*: FCI

exporting more than 10 MMT of rice each year until 2014–2015, when rice exports reached 12 MMT.

Rising grain stocks also encouraged the government to introduce a bill in the parliament in 2011 and then enact the National Food Security Act (NFSA) in 2013.

14.3.7 National Food Security Act, 2013

By ensuring ample food stocks with a robust and expanding production base, the country appeared to have attained food security at the national level. However, as highlighted before, the situation at the microlevel was bleak, with widespread malnutrition and stunting among the population. Backed by the growing food grains stocks, the government enacted the NFSA in 2013.

The PDS is the tool through which the government of India improves food security at the microlevel. The FCI is the nodal agency which procures, stores, and distributes grains (mainly rice and wheat) to states, which in turn distribute it to the identified beneficiaries under the various food-based welfare schemes run by the central government of the country. Appendix (Fig. 14.16) summarizes the evolution of the PDS. The depth, scope, and coverage of the PDS expanded under the NFSA 2013. The Act aims to solve the problem of food and nutritional security of the Indian population. It combines and expands some existing *food-based* welfare schemes and a *conditional cash transfer* scheme. The Act is likely to be the biggest program of its kind so far and aims at reaching more than 800 million people (67 % of India's population), with an annual, legally enforceable distribution commitment of 61.4 MMT of grains sold at highly subsidized prices (with almost 90 % subsidy).

A legal commitment of such quantum of grains is likely to put greater pressure on the government's procurement machinery which would need the farmer to continue (and possibly increase) his production of the two crops. Price incentives are important drivers of farmer behavior (Gulati et al. 2013), and future MSP increases thus form an inevitable tool under NFSA. If the Act, in its present form, is to deliver on its set objective of alleviating poverty and malnutrition, commensurate price incentives have to be put in place. Supplying the committed 61.4 MMTs of grains necessitated the government to revisit its quarterly buffer-stocking norms. The government has already approved a newly revised, quarterly buffer stock norm (with higher norms for three quarters).

The Act is currently unfolding in the country and faces several challenges ranging from large leakages in the PDS and distortions in production basket to ballooning food subsidy bill (Saini and Gulati 2015). There are apprehensions about the capacity and the ability of the act to deliver on its set objectives. The problem is caused by the inefficiency of the existing PDS machinery, which forms the base of implementing the Act. The machinery is marred with inefficiencies and redundancies. (Saini and Kozicka 2014) There are talks of substituting the systems with a dynamic platform of direct cash/benefit transfer (DBT), whereby instead of physical grains an equivalent amount of cash will be transferred into the account of the beneficiary. Four Indian union territories (UTs)—Chandigarh, Puducherry,

Daman and Diu, and Dadra and Nagar Haveli—have agreed to introduce the DBT scheme in September 2015. Out of 36 Indian states/UTs, 13 have started implementing the provisions under the Act.

Falling yields in the traditional rice-growing states and the lowering water tables is one of the big challenges faced by the country today. Feeding the growing grain needs of the country necessitates the urgency to create alternative supply stations in the country. Therefore, the resource-rich Eastern states of Bihar, UP, Jharkhand, and Assam need to evolve into becoming the future supplier of rice in particular. The Second Green Revolution is likely to begin in Eastern India this time.

14.3.8 Second Green Revolution

Eastern India, with 2–3 times more rainfall compared to the Northwest states, has underused its high-quality groundwater aquifers. Vast social capital resource gives Eastern India a relative advantage in terms of sustainable rice production. The Eastern states account for 56 % of the total rice planting area in India but produce only 48 % of the total rice production. The productivity levels in the Eastern states, except Uttar Pradesh and West Bengal, are among the lowest in India. Out of the 26.6 million ha rice planting area in Eastern India (UP, Bihar, Jharkhand, West Bengal, Assam, Orissa, and Chhattisgarh), approximately 14.3 million ha is rainfed and thus prone to different abiotic stresses like flooding, drought, and soil salinity/sodicity. These abiotic stresses are the single most important yield-limiting factor for rice production in Eastern India. The rice productivity of Eastern India, except UP and West Bengal, is not only low (1.7–2.5 tns/ha) but also fragile.

The central government has been allocating money under *Rashtriya Krishi Vikas Yojana* from 2010 to 2011 for extending the Green Revolution to the eastern regions of the country comprising of Bihar, Jharkhand, Eastern UP, Chhattisgarh, Orissa, and West Bengal. The objective is to increase the productivity of crops, mainly rice, wheat, maize, pulses, by intensive cultivation through the promotion of recommended agriculture technologies, package of practices and high-yielding stress-tolerant hybrid rice varieties.

14.4 Lessons Learned and the Way Forward

Overall, the experience of 2007–2008 did play a significant role in India's agriculture sector. Country's intrinsic aversion to volatile food prices coupled with a disinclination to importing food to feed its population led the policymakers to act the way they did during the food crisis of 2007–2008.

However, the country learned three key lessons from the food crisis. First, price incentives are important for Indian farmers, whose encouraging response to raising the MSP under the NFSM brought the country to new heights in the global trade. Second, India is not insulated from global events, and putting export bans offers only a temporary respite to the domestic food prices, which in the longer run

converged with their global counterpart. Third, agriculture could be a large source of foreign exchange (net exports) for the country. As evident in the trade flows and demonstrated using a Balassa Index,[1] India has a higher relative trade advantage in agriculture than manufacturing. Yet the country has not been able to tap the full potential of the sector because of its restrictive agricultural trade policies.

Therefore, to harness the full potential of the agricultural sector, there is a need to ensure that agricultural trade policies are consistent, stable, predictable, and conceived for the long term. Concerted efforts, however, should be made for aligning domestic and international prices while guarding against sharp price spikes and troughs through constant monitoring and applying calibrated tariffs rather than outright bans.

Food security has been and will continue to be one of the primary concerns of the country's agriculture and food sector. The NFSA 2013 is seen as a vital step in alleviating the issue of widespread poverty and malnutrition. Apprehensions about the inability of the Act to deliver on the set objectives are widespread. There are even talks about substituting the entire system of subsidized physical grain distribution (price policy) with direct cash transfers (income policy), but a complete substitution is still unlikely in the short run. Given the slow pace of policy changes, it may take 3–5 years to transition from physical transfers to cash transfers once the government decides to implement the changes. Therefore, the country would remain dependent on and sensitive to any factors affecting food crops like rice and wheat, particularly with regard to their production and price levels.

However, the country's policymakers should dilute the intrinsic bias of the policy and the policy incentives toward food grains (mainly rice and wheat), which have resulted in inefficient resource allocation and usage. The country needs to reorient its agriculture sector and policies by calibrating them with two things: the changing consumption patterns of the Indian population and the relative comparative advantage that the country's agricultural sector has globally. While the former would bridge the increasing gap between the "plough" and the "plate," the latter would help the country reap benefits from trade in terms of efficiency.

Apart from crops, the country's policymakers have an inherent bias toward certain regions. The Second Green Revolution, which is envisaged to be a game changer for the Eastern states, is a step in the right direction, with the focus shifting away from the traditional northern and southern agricultural states. This evolution should be accompanied by a reorientation of the roles of the many stakeholders, with the public sector playing a much smaller role in the food market in the future.

[1] Balassa Index for revealed comparative advantage: It is an index used in international economics for calculating the relative advantage or disadvantage of a certain country in a certain class of goods or services as evidenced by trade flows. It is based on the Ricardian comparative advantage concept. For year 2013–2014, value of the index for agriculture is 1.37 and that of manufacturing is 0.8, thus indicating India's relative advantage in agri trade than manufacturing.

India is an important economy in the global food space and is naturally interdependent with the world. By having a stable long-run trade policy, creating institutions and infrastructures to facilitate trade, and focusing on promoting resource allocation in line with its inherent competitive advantage, the country will not only tap the full potential of its agricultural sector but will also benefit the world immensely.

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Appendix

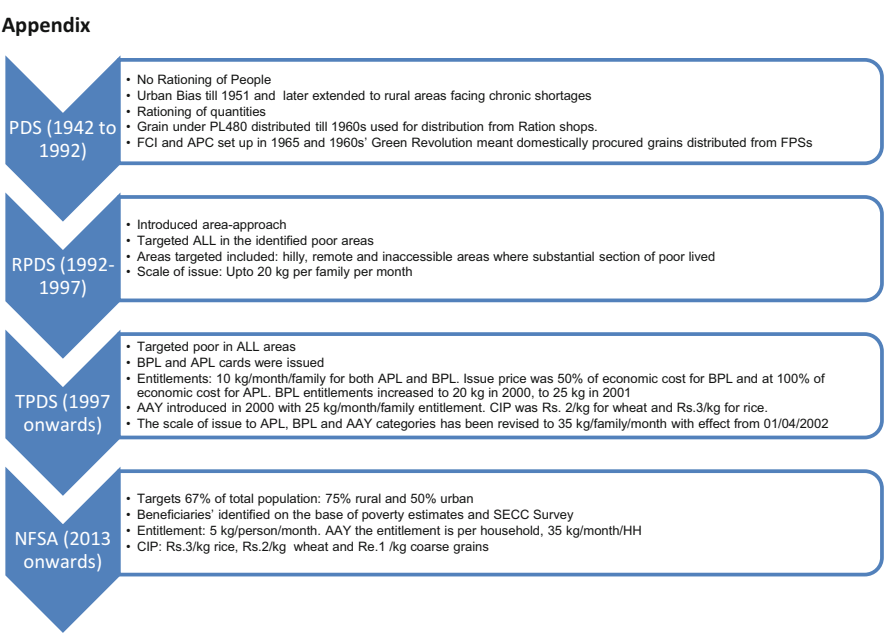

Fig. 14.16 Brief about the evolving system of PDS in India. *Source*: Saini and Kozicka (2014)

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The Costs and Benefits of Regional Cooperation on Grain Reserves: The Case of ECOWAS

15

Lukas Kornher and Matthias Kalkuhl

15.1 Introduction

Despite widespread skepticism towards public intervention in food markets, many governments in sub-Saharan Africa and elsewhere in the world responded to the 2007/2008 global food crisis by implementing or enhancing public stockholding. These interventions are criticized due to their distortive effects on private trading and their high operating costs (Newbery and Stiglitz 1981; Miranda and Helmberger 1988; Tschirley and Jayne 2010). On the other hand, the crisis also showed that international trade is incapable of dampening supply and price shocks when exporters insulate their domestic markets from the international price development (Martin and Anderson 2012; Porteous 2012).

Child mortality and general food insecurity in West Africa are among the highest in the world (FAO et al. 2013; von Grebmer et al. 2013). The region is a major rice importer and is dependent on these imports to meet food consumption targets. International food aid has been an important factor in offsetting fluctuations in national production but has been decreasing rapidly since the middle of the last decade (FAOSTAT 2014). For these reasons, the Economic Community of West African States (ECOWAS) community decided to make plans for a regional emergency reserve.[1]

[1]For a detailed description of the current proposal, see ECOWAS Commission et al. (2012).

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Regional food reserves are viable and comparably cheap means, as an alternative to national reserves (FAO et al. 2011; Wright and Cafiero 2011). This is not a new idea. International risk sharing and multinational insurance schemes were heavily discussed in the 1970s (Johnson 1976; Reutlinger et al. 1976; Konandreas et al. 1978). As with the concept of any insurance, pooling national supplies stabilizes regional food availability due to the imperfect correlation of national production shocks (Koester 1986). However, potential benefits of cooperation can only be realized when countries agree on common rules under which the reserve operates. In other words, how much each country contributes and under which circumstances releases from the reserve are authorized. This requires that all countries benefit from cooperation vis-à-vis without cooperation.

Academic literature on regional storage cooperation is scant. Existing studies underline the potential of risk sharing without explicitly conceptualizing the link to storage. This study aims at closing the gap by providing a methodology to evaluate potential benefits of regional storage cooperation. The main objective is to examine whether storage cooperation could enhance food security in West Africa. Specifically, various possible storage policies are tested, and an efficient load distribution among participating countries is discussed. Generally, the methodology is applicable to any group of countries and not limited to West Africa.

The remainder of the chapter is structured as follows. First, Sect. 15.2 discusses food security and storage as well as trade as means to increase food availability and introduces the concept of regional cooperation. Then, Sect. 15.3 and Sect. 15.4 outline the framework for assessing the benefits of cooperation and then define optimal levels of storage in the presence of stochastic supply with the goal of stabilizing national consumption. The results of this study, including sensitivity analysis, are presented in Sect. 15.5. Section 15.6 concludes this chapter and discusses policy implications.

15.2 Food Reserves, Trade, and Benefits of Regional Cooperation

Annual production is subject to great fluctuation and consequently may be insufficient to meet stable consumption needs in non-exporting economies. Food imports and stocks can offset these fluctuations. The empirical literature emphasizes the interchangeability of trade and storage to offset unstable production (Williams and Wright 1991; Makki et al. 1996, 2001). There are good reasons to believe that free market stock levels in many developing countries are not sufficiently high or optimal (Newbery and Stiglitz 1981; Gilbert 2011). Similarly, the potential gains from regional trade are not exhausted in many developing countries (Badiane et al. 2014). Gilbert (2011) suggests considering a country's specific characteristics to determine the right policy. So, exporters can easily regulate domestic food availability by flexible export quantities. Trade is also advantageous if supply shocks between countries are independent or negatively correlated (Koester 1984; Badiane et al. 2014). In contrast, importers and countries that switch between net importer

and net exporter can successfully insure themselves against high international prices by keeping security stocks. Furthermore, high transportation costs (e.g., for landlocked countries) and/or long periods of shipment make public reserves favorable to trade. Trade can also transmit market instability from partner countries into national markets (Makki et al. 2001). Moreover, relying on imports to manage food availability can be problematic when partner countries are noncooperative and restrict exports at times (Gouel and Jean 2015). This was a frequently observed practice during the price surges in 2007/2008 (Martin and Anderson 2012; Porteous 2012). For these reasons, food reserves have a structural advantage over trade integration, at least from a government's perspective.[2]

Food reserves can be divided into two broad categories: emergency or strategic reserves and buffer stocks. The purpose of the former is to overcome food supply shortfalls caused by weather-related shocks (such as droughts or floods), pests, and political instability (Lynton-Evans 1997). During a crisis, additional food is brought into the system via targeted food subsidies (e.g., food stamps, food for work, school feeding programs, etc.). In contrast, buffer stocks are used to generally stabilize commodity prices at both ends of the distribution. In doing so, public institutions buy and sell commodities in order to increase market supply or demand. The objective of the buffer stock is to keep prices within a price band, between a predetermined floor and ceiling price (Newbery and Stiglitz 1981). Purchases and sales can be realized not only in the open market but also through contract farming and subsidized sales to public and private entities. The main danger lies in having to operate buffer stocks permanently, which implies permanent market intervention. Notably, intervention levels of existing national reserves and buffer stocks vary significantly across countries.[3]

The gains from cooperation rest on the concept of risk pooling. Risk pooling, or diversification, originates from the insurance and finance literature and is the central business concept of every insurance company. Pooling uncertain outcomes of multiple individuals reduces the volatility of their joint outcome. Expected losses remain the same, but insurance companies can reduce their accrued liabilities if (and only if) losses of policyholders are not perfectly correlated. On the same account, a group of countries can reduce the stocking norm of their food reserves by sharing the risk of supply shocks. Statistically, the covariance and correlation of individual risks is the key determinant for gains from cooperation. If shocks are idiosyncratic, then risk sharing is feasible. On the contrary, if shocks are highly correlated, the benefits of cooperation will be small (Townsend 1995). From this, it is possible to conclude

[2]On the one hand, deepening trade relationships require trading partners to be equally willing to cooperate; on the other hand, trade integration usually takes time to establish business relations and trust between actors.

[3]Agricultural markets in India, Zambia, and Indonesia are dominated by state-owned enterprises that buy, stock, and sell a very large share of marketed grains. In contrast, several countries maintain public stockholding that is unlikely to affect market prices due to its small size. In an ideal world, buffer stocks should be large enough to influence prices but small enough not to crowd out private investment and distort markets.

that supply instability in one region (a group of countries) is lower if national supply quantities are independent or negatively correlated. The potential of regional risk sharing with respect to supply shocks of major food crops in Africa is well acknowledged in existing studies (Koester 1986; Badiane et al. 2014). Since supply variability is the main reason to establish food reserves, lower supply variability implies that a reserve requires lower stock levels.

Wright and Cafiero (2011) also discuss the role of regional reserves in increasing a country's commitment to refrain from imposing export regulations in times of a food crisis. These commitments seem unfeasible under the common WTO discipline. At the same time, governments dispose of ways to impede exportation through the over-bureaucratization of legal processes. Hence, it is conceivable to combine storage and trade cooperation. In doing so, participating countries provide a share of their national supply for exporting (if harvests are sufficiently high) and in return receive the entitlement to release stocks during a crisis.

A multinational reserve involving a buffer stock scheme, with market purchase and release, seems very challenging to realize. If the regional reserve operates separately at national levels, trade between countries would undermine the principles of operation and could lead to complete inefficacy. On the contrary, if the region is considered as a single market, intervention prices are extremely difficult to determine since price levels naturally differ among member countries, especially without a common currency. Therefore, strategic humanitarian reserves should be preferred.

15.3 Assessment of the Costs and Benefits of Cooperation

In order to assess the costs and benefits of regional cooperation, we compare consumption variability and reserve levels under regional cooperation vis-à-vis without cooperation. In other words, optimal stocking norms are defined for each individual country and for specific groups of countries. If a country's welfare is given by:

$$U = H\ [\mathrm{VAR}\,(C\,(\alpha))] - G\,(\alpha)\,, \tag{15.1}$$

where H is a function decreasing with consumption variability $\mathrm{Var}(C)$ and G, the costs of interventions that increase with the stock-to-use ratio α; $\alpha \in (0,\ 1)$ reduces consumption variability and thus increases H in the following manner: $H'\,(\alpha) > 0$ and $H''\,(\alpha) < 0$.

Then welfare increases with consumption stability and decreases with higher reserve stock levels. A government chooses the optimal policy by opting for a stock-to-use ratio (α) that maximizes social welfare. Accordingly, there is a trade-off when increasing the stock level of the reserve. Higher stock levels guarantee greater consumption stability but are associated with higher operational costs.

The optimal α maximizes social welfare without cooperation. On the contrary, in the case of regional storage cooperation, the level of consumption variability, and thus the optimal stock-to-use ratio, is no longer determined by an individual country through welfare optimization but by a common decision among all member countries. Heterogeneity among regional partners could explain why they may disagree about common regional policies. For instance, countries with high supply instability may be satisfied with a relatively moderate level of consumption stability, whereas countries with stable national supply need regional consumption stability to be sufficiently high to benefit from an intervention. In regional integration, states voluntarily hand their decision-making power over to supernational entities and create a political power that overrules national policies (Heinonen 2006). Taking a game-theoretic approach, the median voter will decide on the level of consumption stability in such a setting (Alesina et al. 2005). As a consequence, countries with similar economic structures lose less in comparison with countries with divergent economic structures.

Thus, the benefits of regional risk sharing are evaluated against the costs of a potentially suboptimal choice of stock-to-use ratio. Following the framework mentioned above, the net benefits (X_i) of cooperation for each country i are given by the difference in social welfare before and after joining the regional agreement:

$$N_i = H_i\left[\mathrm{VAR}\left(\widehat{C}_i\right)\right] - H_i\left[\mathrm{VAR}\left(C_i^*\right)\right] + G_i\left(\alpha_i^*\right) - G_i\left(\widehat{\alpha}_i\right) \tag{15.2}$$

where $\mathrm{VAR}\left(C_i^*\right)$ is the consumption variability resulting from the optimal α_i^* for an individual country without cooperation or the optimal level of target consumption chosen by the country. Analogously, $\mathrm{VAR}\left(\widehat{C}_i\right)$ is the consumption variability under cooperation determined by $\widehat{\alpha}$, which is jointly selected by the member countries.

However, without specifying the functions H_i and G_i, welfare impacts are not unambiguously appraisable. Definite predictions are possible when benefits increase and costs decrease and vice versa. Yet in the remaining cases, a specific functional form of H_i and G_i is required for a clear assessment.

The framework introduced requires the definition of optimal stocking rules or stock-to-use ratios that are applied by each country. This implies stocks need to be sufficiently high to permit stock releases that achieve the desired level of consumption (stability). At the same, the policy governing the release of stocks from the reserve must be strictly defined. Within regional storage cooperation, the member countries must contribute to the endowment of the regional reserve. These contributions could be proportionally equal. In this case, all countries would have identical stock-to-use ratios. Alternatively, Koester (1986) proposes that a country should contribute according to its individual stock needs. In doing so, countries with greater supply instability would be asked to contribute more than countries with greater supply stability. In this way, all countries would benefit from the cooperation in the same manner. Again, the releases from the reserve must make sure that the desired consumption (stability) is given for each member country. This means that whenever a country's supply falls short of its target level (specified in the

rules of the reserve), the country would receive stocks from the regional reserve to guarantee national consumption. As opposed to this, if a country's domestic supply is sufficient in satisfying domestic demand in a particular year, then the country does not receive anything from the regional reserve.

15.4 Optimal Stocks and Stocking Rule

In this analysis, two possible types of reserve are considered: an emergency reserve, which releases stocks whenever supply falls short of a predetermined level, and a buffer stock regime, which stabilizes supply in both directions.

15.4.1 Emergency Reserve

In line with the existing literature, the optimal reserve level should be able to absorb historical production and supply shocks by a predetermined probability or margin (Johnson 1976; Konandreas et al. 1978; Koester 1986). Let the market identity be given by:

$$C_t = Q_t + \mathrm{IM}_t - \mathrm{EX}_t = X_t \tag{15.3}$$

where total consumption (C_t) equals production (Q_t) plus imports (IM_t) minus exports (EX_t). Imports and exports are assumed to be from international markets only. National production and imports constitute total national supply (X_t).

In case production falls short of the desired level, minimum consumption of a country can be satisfied through additional imports. However, food availability has generally (not only in the case of West Africa) seen drastic variations from year to year despite food imports. Furthermore, international food prices fluctuate and therefore make the food import bill unpredictable (Sarris et al. 2011). In such a situation, the emergency reserve would step in to lift consumption to the desired minimum level. Following Konandreas et al. (1978), the desired minimum level is referred to as target consumption level c^* (e.g., 95 % of long-term trend). Then, consumption in a given year is given by:

$$C_t = \max\left[X_t, c^* E\left[C_t\right]\right] \tag{15.4}$$

where X_t, is the actual supply in at t, and $c^* E\left[C_t\right]$ is the target consumption based on expected supply that is calculated from historical values. By definition $c^* \in [0, 1]$.

In words, when national supply is higher than the target level, consumption just equals total supply. But whenever supply is lower than the target level, the reserve releases the necessary amount to close the gap to satisfy at least $c^* \times 100\%$ of the expected consumption. Consumption is expected to always equal supply. In order to satisfy Eq. (15.4), stocks need to compensate for supply shortfalls of more than $(1 - c) \times 100\,\%$. Subsequently, the ratio of consumption to be stored (α) is defined

as the ratio between stocks and expected consumption:

$$S_t^* = \max_t \left[0,\ c^* E\left[X_t\right] - \left(X_t\right)\right] \text{ for } t = t_1, \ldots, t_n \tag{15.5}$$

$$\alpha_t^* = \frac{S_t^*}{E\left[C_t\right]} \tag{15.6}$$

where $\max_t \left[c^* E\left[X_t\right] - \left(X_t\right)\right]$ is the largest historical supply shortfall over the period t_1–t_n. If supply never falls below $c^* E\left[X_t\right]$, no stocks shall be carried. S_t^* are optimal stocks, and α_t^* is the optimal stock-to-use ratio at present time.

In regional cooperation, the reserve must carry sufficiently large stocks to satisfy the sum of supply shortfalls in all member countries, so that regional consumption is given by

$$C^R{}_t = \sum_i C_{it} \tag{15.7}$$

where $C^R{}_t$ is the regional consumption, which is the sum of the consumption in each member country given by Eq. 15.4.

Accordingly, the individual national reserves carry total regional stocks which are the sum of national stocks:

$$S_t^R = \sum_i S_{it}^* = \sum_i \max_t \left[0,\ c^*{}_i E\left[X_{it}\right] - \left(X_{it}\right)\right] \text{ for } t = t_1, \ldots, t_n \tag{15.8}$$

where S^R is the amount of regional stocks and all other parameters are described as above.

If national supply shortfalls are not perfectly correlated, then the common regional reserve must carry only enough stocks to balance the sum of the shortfalls that occur in a particular year.

$$\widehat{S}_t^R = \max_t \left[0,\ \sum_i \widehat{c}\, E\left[X_{it}\right] - \left(X_{it}\right) \right] \text{ for } t = t_1, \ldots, t_n \tag{15.9}$$

where $\max_t \left[0,\ \sum_i \widehat{c}\, E\left[X_{it}\right] - \left(X_{it}\right)\ \right]$ is the largest historical regional supply shortfall over the period t_1–t_n.and $\widehat{c}$ is the consumption target in a regional cooperation which does not vary between member countries i. If supply never falls below $\widehat{c}\, E\left[X_t\right]$, no stocks shall be carried.

The regional reserve shall be endowed with stocks by contributions from its member countries. In this instance, national stocking norms change to:

$$\widehat{S}_{it} = s_i\, \widehat{S}_t^R = \widehat{\alpha}_t E\left[X_{it}\right] \tag{15.10}$$

$$\text{with } \widehat{\alpha}_t = \frac{S_t^R}{E\left[{C^R}_t\right]} \tag{15.11}$$

$$\widetilde{S}_{it} = \frac{S_{it}}{\sum_{i=1}^{n} S_{it}} S_t^R \tag{15.12}$$

where s_i is a country's share of the total regional consumption; $\widehat{S}_{it}$ and $\widetilde{S}_{it}$ are a country's contributions to the regional reserve under equal and relative contributions. Under equal contributions, all countries have the same stock-to-use ratio $\widehat{\alpha}$ in t. Under relative contributions, $\widehat{\alpha}_i$ varies among countries by the extent to which national stocks vary across countries without regional cooperation.

However, regional storage cooperation and intra-regional trade cooperation can work hand in hand. For instance, it is conceivable to assume that supply surpluses are exported to the region. Hence, supply shortfalls in neighboring countries can be first alleviated through trade before releasing stocks from the regional reserve. Storage cooperation could also increase the commitment to such arrangements (Wright and Cafiero 2011).

A reasonable assumption may be that a country's excess surpluses $\text{ES}_{it} = X_{it} - E\left[X_{it}\right]$ are approved for export. Thus, intra-regional trade and regional stocks are given by:

$${T^R}_t = \sum_i \max\left[0,\ X_{it} - E\left[X_{it}\right]\right] \tag{15.13}$$

$$S_t^R = \max_t \left[0,\ \left[\sum_i \widehat{c}E\left[X_{it}\right] - \left(X_{it}\right)\right] - {T^R}_t\right] \text{ for } t = t_1, \ldots, t_n \tag{15.14}$$

where ${T^R}_t$ is the total quantity traded within the region in a particular year, which is computed as the sum of excess surpluses across all member countries. Regional trade reduces the amount of regional stocks, which are necessary to alleviate supply shocks. Therefore, historical shortfalls, which have to be balanced, diminish with growing amount of intra-regional trade. Contributions of member countries and stock-to-use ratios can be computed in a way analogous to the case without intra-regional trade.

15.4.2 Stabilization Reserve

As opposed to the emergency reserve described in the previous section, the concept of the stabilization reserve is derived from the classical storage literature (Gustafson 1958). Stocks are regarded as part of national supply and demand. Each year, a constant portion (γ) of the total available supply is kept as stock in a reserve; this

is a linear approximation of the stocking rule pioneered by Gustafson. In this way, stock levels change over time. After years with good harvests, stock levels will be become higher (and will correspondingly become lower after bad harvests). In this case, the market identity from Eq. (15.3) above changes to:

$$C_t = \mathrm{X}_t - \Delta S_t \tag{15.15}$$

$$\Delta S_t = S_{t+1} - S_t \tag{15.16}$$

$$S_{t+1} = \gamma \left(S_t + X_t\right) \tag{15.17}$$

where all parameters are defined the same as above. S_t is opening stocks available for consumption in t, and S_{t+1} are the stocks carried to the next period. ΔS_t is the change in ending stocks from $t-1$ to t. γ is the constant portion of total available supply that is carried over to the next period.

Inserting Eq. (15.15) in Eq. (15.14), consumption can be written as[4]:

$$\mathrm{C}_t = (1-\gamma)\left(X_t\right) + (1-\gamma)\, S_t \tag{15.18}$$

Since supply naturally fluctuates, we want to know the expected level of stocks. This can be easily derived since $E\left[S_t\right] = E\left[S_{t+1}\right]$. Thus,

$$S_t^* = \frac{\gamma E\left[X_t\right]}{(1-\gamma)} \tag{15.19}$$

$$\alpha^* = \frac{\gamma}{1-\gamma} \tag{15.20}$$

where S_t^* is the optimal stock level and α^* the corresponding optimal stock-to-use ratio.

The objective of the stabilization reserve is to stabilize consumption. Hence, it is of interest is to investigate how consumption variability depends on the stocking parameter (γ). Taking the variance of Eq. (15.18) yields:

$$\mathrm{VAR}(C) = \frac{1-\gamma}{1+\gamma}\mathrm{VAR}(X) \tag{15.21}$$

$$\mathrm{CV}(C) = \sqrt{\frac{1-\gamma}{1+\gamma}}\mathrm{CV}(X), \tag{15.22}$$

[4]For the complete analytical derivation, see Kornher (2015).

where VAR (C) and VAR (X) are variance of consumption and supply, respectively, and CV (C) and CV (X) are the respective coefficients of variation.

Consequently, consumption variability is a function of supply variability and the stocking parameter (γ). The larger the supply variability, the larger the consumption variability. On the other hand, increasing γ stabilizes consumption. It is important to note that the stabilization reserve in the case of regional storage cooperation works only if markets are fully integrated and if demand and supply adjust perfectly between countries. In this case, regional supply and consumption variability are equal to national supply and consumption variability for each individual member country.

15.5 Results

15.5.1 Supply Patterns in West Africa

Table 15.1 provides economic and agricultural statistics on West African countries involved in this analysis. Heterogeneity between countries exists with respect to income level and food security status. While Ghana and Cape Verde have relatively low prevalence of hunger and malnutrition, 12 % of the total ECOWAS population is still undernourished, with alarmingly high figures in the Sahel zone. With the exception of Mali and to some extent Burkina Faso, all countries depend on imports to guarantee sufficient supply of grain. In general, it is observed that coastal countries have larger import-to-production ratios, with Cape Verde, Cote d'Ivoire, Liberia, Senegal, and Mauritania having ratios above one. Overall, Nigeria's prominent role in the region is to be noted. Due to the country's population, more than 40 % of regional production originates from Nigeria, and thus the country would likely assume a leading role in any regional cooperation agreement.

The subsequent analysis is based on fluctuations in national food production and supply. Supply is calculated as production plus imports. In this way, extreme fluctuations in the production of many import-dependent countries are extenuated. Therefore, the analysis of supply shocks is considered to be more instructive. All imports are considered to be from international markets. In the analysis which considers intra-regional trade, these international imports are considered to be part of the national supply.

Since production increases with agricultural productivity and population growth, unadjusted measures of variability as variance and coefficient of variation become inappropriate measures of variability (Cuddy and Della Valle 1978). One possibility is to correct coefficient of variation and variance by the fitness of a trend function (Koester 1984). Alternatively, variability can be measured after detrending the time series. Thus, variability in supply is given as the variation around a trend. A linear

Table 15.1 Key statistics: ECOWAS

	Population (in 100,000)	GDP per capita PPP	% of under-nourished	Total production (in 1000 mt)	Import/ production (in %)
Benin	10,323	1791	8.1	1667	21
Burkina Faso	16,934	1634	25.9	4949	9
Cape Verde	498	6412	–	7	2.86
Cote d'Ivoire	20,316	3012	21.4	1276	116
Gambia, The	1849	1666	14.4	214	58
Ghana	25,904	3974	3.4	2645	44
Guinea	11,745	1255	17.3	2292	21
Guinea-Bissau	1704	1242	8.7	175	74
Liberia	4294	878	31.4	150	227
Mali	15,301	1641	7.9	5032	3
Niger	17,831	913	12.6	4308	13
Nigeria	173,615	5863	8.5	22,042	32
Senegal	14,133	2269	20.5	1182	150
Sierra Leone	6092	1927	28.8	897	28
Togo	6816	1390	16.5	1142	23
Total ECOWAS	327,355	4123	12	47,978	30
Cameroon	22,253	2711	15.7	3047	37
Chad	12,825	2081	33.4	1647	18
Mauritania	3889	3042	9.3	222	207

Source: AFDB (2014), von Grebmer et al. (2013), USDA (2014). *Note*: Mauritania withdrew from ECOWAS in 2000; CFA countries are Benin, Burkina Faso, Cameroon, Chad, Cote d'Ivoire, Guinea-Bissau, Mali, Mauritania, Niger, and Senegal; all other countries use their own free floating currency

trend clearly does not fit the supply data of several countries in the region. Therefore, the data is detrended by using the Hodrick-Prescott filter (HP-filter).[5]

An example is given in Fig. 15.1, which shows the national supply in Ghana. Actual supply quantities are depicted by the black line, and the dashed gray line indicates the HP-filter trend values for a smoothing parameter of 6.25. The deviation of actual supply from trend supply becomes stationary, and variability can be computed by:

$$\mathrm{CV} = \sqrt{1/n \sum \left(\mu - X_t/\overline{S_t}\right)^2}/\mu, \tag{15.23}$$

[5]The HP-filter is widely used to detrend macroeconomic time series data that exhibits cyclical fluctuations. The estimated trend value is given by the minimization of quadratic deviations in due consideration of a smooth trend. As recommended for annual data, the smoothing parameter is chosen to be 6.25 (Gabler Wirtschatfslexikon 2014).

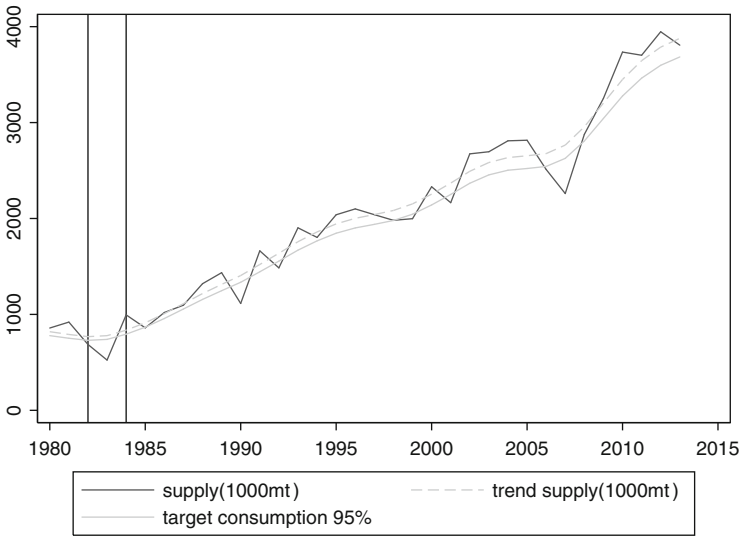

Fig. 15.1 Grain supply in Ghana 1980–2014. *Source*: Author's illustration based on USDA (2014)

where X_t is the total supply in t and $\overline{X_t}$ the trend value of supply determined by the HP-filter. By definition, μ equals 1.

Table 15.2 shows each country's contribution to the total regional grain supply in 2014 as well as the coefficient of variation in production and supply over the period from 1980 to 2014. In brief, there are two general observations. First, supply variability is substantially lower than production variability, in particular for countries with high import-production ratio. Second, no country exhibits production and supply variability that is lower than the figure for the region as a whole. Therefore, the basic requirements for the West African region to benefit from cooperation are fulfilled.

In more detail, production variability is highest for Cape Verde, Mauritania, Senegal, the Gambia, and Chad. All these countries largely depend on import. However, for all of these countries, supply variability is significantly lower. This implies that imports were successfully utilized to stabilize domestic consumption, but the import levels are still higher than in countries with greater self-sufficiency. In general, coastal countries show higher production and supply stability; this can be explained by more favorable climatic conditions in the humid and semi-humid tropical zone compared to the Sahel zone (HarvestChoice 2014). Interestingly, these findings with regard to instability are quite similar to those of Koester (1984), who looks at the period from 1960 to 1980. According to his analysis of the UEMOA countries, Burkina Faso, Cote d'Ivoire, and Mali had more stable production than Senegal, Mauritania, and Niger. The observed pattern seems to persist over time.

Table 15.2 Production and supply instability in West Africa

	Share in regional production	CV production	Share in regional supply	CV supply
Benin	2.9	7.6	2.7	7.6
Burkina Faso	8.9	10.3	7.5	9.1
Cameroon	5.7	7.2	6.0	6.0
Cape Verde	0.0	43.8	0.0	30.3
Chad	3.4	15.7	3.0	13.3
Cote d'Ivoire	2.4	5.5	4.0	5.7
Gambia, The	0.4	16.1	0.5	14.4
Ghana	5.0	14.0	5.6	10.2
Guinea	4.2	5.5	3.9	5.6
Guinea-Bissau	0.4	9.8	0.4	10.3
Liberia	5.0	16.1	0.7	14.8
Mali	10.4	9.7	8.1	9.4
Mauritania	0.4	27.6	1.0	9.6
Niger	8.7	13.5	7.4	12.0
Nigeria	40.6	5.8	41.2	5.4
Senegal	2.4	18.0	4.3	8.3
Sierra Leone	1.5	13.8	1.6	11.1
Togo	2.1	10.2	2.0	8.1
Region	100.0	4.5	100.0	3.4

Source: Author's computation based on USDA (2014)

15.5.2 Emergency Reserve

This subsection discusses the optimal stocking norms for an emergency reserve as defined earlier. The target consumption level is the critical parameter to be chosen. A target consumption level of $j\,\%$ can be represented by $j\,\%$ of annual production (dashed line in Fig. 15.1).[6] The lighter solid line in Fig. 15.1 illustrates this for a target consumption level of 95 %. Then, the deviation of actual supply from target consumption is computed, and the maximum historical shortfall is identified. In the instance of Ghana, the largest shortfall happened in 1983. The size of the shortfall depends on the target consumption chosen. Target consumption levels of individual countries are hypothetical and cannot be observed. A possible way to determine target consumption levels is to assume that each country uses the reserve to mitigate x- % of the largest supply or production shock. From the standard deviation of these shocks of each country, the target consumption level with respect to any quantile can be computed. Normalized standard deviations are equal to the coefficient of variation shown in Table 15.2. Figure 15.2 shows the target consumption levels

[6]Recall that production/supply = consumption.

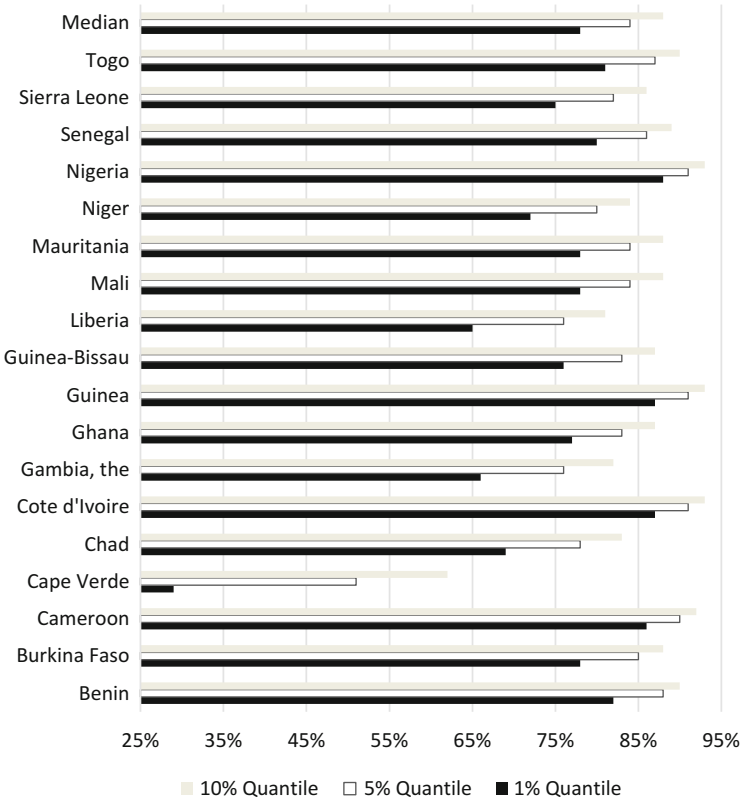

Fig. 15.2 Possible target consumption levels by country. *Source*: Author's illustration

across countries for the 1 %, 5 %, and 10 % quantiles when assuming a normal distribution of supply shocks.[7]

Figure 15.2 contains important information. Intuitively, the larger the tail of the distribution (the greater the quintile), the lower target consumption will be. First, as elaborated above, higher target consumption levels also require larger stocking norms. Second, target consumption levels would vary significantly among the countries: Nigeria, Cote d'Ivoire, and Guinea would have the highest target consumption levels, and Cape Verde would have the lowest. Third, the lower the national supply variability, the higher the target consumption levels in a particular quintile. This is also intuitive because when national supply is more stable, higher target consumption is required to alleviate a relatively moderate supply shock. In

[7] 1 %, 5 %, and 10 % quantiles reflect the frequency of interventions of the national reserve. Thus, absorbing the 10 % largest supply shocks demands the highest frequency of supply shocks.

the following, the median values will serve as possible target consumption levels for the region.

15.5.2.1 Emergency Reserve Without Intra-regional Trade

The stocking norm is defined as the largest historical shortfall between actual and target consumption over the past 35 years. Table 15.3 summarizes the respective stocking norms for all countries and various levels of target consumption. Apart from the median target consumption levels, the target consumption levels of 99 %, 97 %, 95 %, and 90 % are also considered.

Large countries have the highest optimal stocking norms. The corresponding stock-to-use ratios show the relative level of the stocking norms. All countries that are characterized by high supply variability also have the largest optimal stocking norms within an emergency reserve. The total regional stocks according to the maximum historical shortfall rule are between 231,137 tons and 6.2 million tons. The values for the target consumption levels of 95 % and above are well in the range of the actual stock levels according to USDA and FAO CBS. However, one would choose optimal emergency reserve stocks that are smaller than actual stocks since total stocks also include speculative and working stocks of private market participants. In this respect, lower levels of target consumption seem to be more reasonable.

On the other hand, several countries with low supply variability hardly stock anything at target consumption levels below 95 %, as shown in Table 15.3. For instance, Nigeria and Guinea would not store anything at target consumption levels of 88 % and below and thus would not benefit from regional storage with all stocking norms selected using the median values (shown in Fig. 15.2). At the target consumption level of 84 %, Cote d'Ivoire and Senegal would likely also cease to participate in a regional reserve, followed by Benin, Burkina Faso, Cameroon, Guinea-Bissau, Mali, and Togo for 78 % target consumption. Hence, target consumption levels need to be sufficiently high in order that all West African countries benefit from cooperation. For this reason, only simulation results for target consumption levels of 90 % and above are subsequently presented in the main text. The detailed simulation results for the target consumption level of 95 % are tabulated in the main text in Table 15.4; the detailed results for 90 %, 97 %, and 99 % are presented in the Appendix (Tables 15.6, 15.7, and 15.8).

Under storage cooperation, optimal stocking norms can be significantly lower if shortfalls between actual and target consumption levels are independent or not perfectly positively correlated. The potential for the ECOWAS region to benefit from these independencies of production and supply shocks is underlined by the analysis conducted by Badiane et al. (2014).

Table 15.4 shows the results of having a regional reserve. For both production and supply, the remaining columns contain the optimal stocking norm under the following three scenarios: (1) no storage cooperation under autarky, (2) equal contributions from the countries to the regional reserve, and (3) relative contributions to the regional reserve required under autarky. The first column reveals the probability

Table 15.3 Optimal stocking norms vs. actual stocks in 2014

	Optimal reserve levels: supply														Actual stocks	
	99 %		97 %		95 %		90 %		88 %		84 %		78 %		USDA	FAO CBS
	S_i^*	α_i^*	S_i^*	α_i^*	S_i^*	α_i^*	S_i^*	α_i^*	S_i^*	α_i^*	S_i^*	α_i^*	S_i^*	α_i^*	S_i^*	S_i^*
Benin	152,677	8 %	127,936	7 %	103,195	5 %	42,379	2 %	32,037	2 %	11,354	1 %	–	–	107,000	162,000
Burkina Faso	593,667	11 %	500,825	9 %	407,983	8 %	203,667	4 %	140,506	3 %	55,756	1 %	–	–	364,000	495,000
Cameroon	203,148	5 %	170,363	4 %	148,788	4 %	94,852	2 %	73,277	2 %	30,128	1 %	–	–	148,000	866,000
Cape Verde	15,455	57 %	14,800	54 %	14,144	52 %	12,505	46 %	11,849	44 %	10,538	39 %	8571	32 %	–	7000
Chad	357,082	17 %	317,808	15 %	278,533	13 %	180,347	9 %	141,073	7 %	80,930	4 %	34,576	2 %	106,000	564,000
Cote d'Ivoire	181,273	6 %	139,631	5 %	99,615	4 %	35,635	1 %	10,043	0 %	–	–	–	–	301,000	467,000
Gambia, The	48,382	14 %	41,486	12 %	34,589	10 %	22,209	6 %	19,160	6 %	13,061	4 %	3914	1 %	29,000	48,000
Ghana	477,451	12 %	422,149	11 %	366,847	9 %	228,592	6 %	173,290	4 %	129,889	3 %	83,183	2 %	476,000	325,000
Guinea	124,296	4 %	87,947	3 %	51,597	2 %	10,864	0 %	–	–	–	–	–	–	201,000	511,000
Guinea-Bissau	26,092	8 %	23,423	7 %	20,755	7 %	14,084	4 %	11,415	4 %	6078	2 %	–	–	24,000	69,500
Liberia	53,601	10 %	48,902	9 %	44,203	8 %	32,455	6 %	27,756	5 %	20,446	4 %	12,343	2 %	53,000	56,000
Mali	417,047	7 %	303,936	5 %	223,631	4 %	78,210	1 %	49,735	1 %	2156	0 %	–	–	764,000	855,000
Mauritania	111,038	15 %	101,159	14 %	91,279	12 %	66,580	9 %	56,701	8 %	36,942	5 %	7303	1 %	59,000	95,500
Niger	681,052	13 %	585,455	11 %	503,972	10 %	345,241	7 %	289,035	6 %	176,625	3 %	72,619	1 %	225,000	522,000
Nigeria	2,167,705	7 %	1,572,822	5 %	977,939	3 %	128,646	0 %	–	–	–	–	–	–	1,539,000	850,000
Senegal	308,029	10 %	258,230	8 %	208,432	7 %	83,935	3 %	34,137	1 %	–	–	–	–	197,000	492,000
Sierra Leone	149,723	13 %	134,597	12 %	119,471	11 %	81,657	7 %	66,531	6 %	36,280	3 %	8628	1 %	0	87,000
Togo	117,762	8 %	105,888	7 %	94,014	7 %	64,329	5 %	52,455	4 %	28,707	2 %	–	–	95,000	171,000
Total	6,185,480	9 %	4,957,354	7 %	3,788,989	5 %	1,726,187	2 %	1,189,001	2 %	638,891	1 %	231,137	0 %	4,688,000	6,643,000

Source: Author's computation based on USDA (2014) and FAO CBS (2014). *Note*: Stock level in mt; the difference in stock levels between USDA and FAO CBS is explained by the issues with regard to USDA data and small countries as well as less-traded crops as sorghum and millet that comprise a significant share of total grain consumption in the region

Table 15.4 Optimal stock levels in 2014 for target consumption of 95 %

	Production				Supply			
	P_i	S_i^*	$\widehat{S}_i$	$\widetilde{S}_i$	P_i	S_i^*	$\widehat{S}_i$	$\widetilde{S}_i$
Benin	26 %	98,832	68,249	58,004	29 %	103,195	66,181	66,804
Burkina Faso	26 %	461,771	209,158	271,009	29 %	407,983	182,765	264,111
Cameroon	11 %	163,986	134,570	96,242	14 %	148,788	146,499	96,319
Cape Verde	43 %	7572	298	4444	40 %	14,144	885	9156
Chad	37 %	301,534	79,510	176,968	31 %	278,533	73,389	180,311
Cote d'Ivoire	14 %	84,520	55,554	49,604	20 %	99,615	97,416	64,487
Gambia, The	34 %	70,230	9566	41,217	43 %	34,589	12,069	22,391
Ghana	17 %	287,853	118,080	168,939	26 %	366,847	136,789	237,481
Guinea	17 %	57,988	99,377	34,033	14 %	51,597	96,782	33,402
Guinea-Bissau	29 %	21,528	7566	12,635	31 %	20,755	10,768	13,436
Liberia	31 %	20,306	7941	11,918	31 %	44,203	18,083	28,615
Mali	37 %	216,774	243,921	127,223	31 %	223,631	199,491	144,770
Mauritania	46 %	49,666	9552	29,149	29 %	91,279	25,604	59,090
Niger	29 %	607,626	204,524	356,610	31 %	503,972	182,173	326,251
Nigeria	17 %	928,445	951,527	544,897	14 %	977,939	1,010,583	633,077
Senegal	40 %	429,613	56,908	252,136	26 %	208,432	106,131	134,930
Sierra Leone	31 %	105,992	35,788	62,206	31 %	119,471	38,301	77,341
Togo	23 %	75,671	49,553	44,411	20 %	94,014	48,925	60,861
Total	97 %	3,989,905	2,342,642	2,342,642	97 %	3,788,989	2,452,834	2,452,834

Source: Author's computation based on USDA (2014). *Note*: Stock levels in mt; P_i is the probability of intervention when production and supply are below the target consumption (99 %). S_i^*, $\widehat{S}_i$, $\widetilde{S}_i$ are stocks without cooperation and with equal and relative contributions

of a shortfall in production and supply.[8,9] The last row contains the total stock level of the whole region if the countries operate individual reserves and if they cooperate. Without regional storage cooperation, the total regional stocks amount to 3,989,905 metric tons for production only and 3,788,989 metric tons for supply. In contrast, with cooperation, regional stocks only need to be 2,342,642 and 2,452,834 metric tons. Comparing the two scenarios reveals a 41 % and 35 % reduction in the total storage level for production and supply, respectively. Since relative contributions among the countries imply that all countries benefit equally from the cooperation, the percentage reduction in storage levels applies to all countries alike. The positive effect of a regional storage cooperation holds regardless of the rule of contributions (equal or relative), but two countries, namely, Guinea and Nigeria, are disadvantaged in the case of proportionally equal contributions. Figure 15.3 shows the difference between the effects of both types of contributions on each country. It becomes evident that countries with relatively low levels of supply variability would prefer

[8]Equal contributions imply, proportionally equal to a country's share in regional consumption.

[9]The probability of shortfall is computed from historical shortfalls.

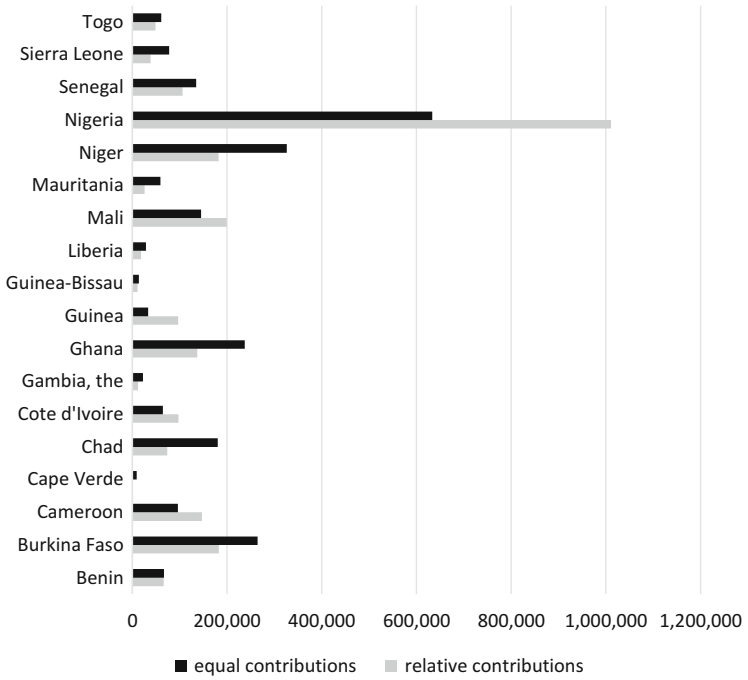

Fig. 15.3 Contributions to a regional reserve with 95 % target consumption by country (based on supply). *Source*: Author's illustration based on USDA (2014). *Note*: Equal contributions to the reserve imply an identical stock-to-use ratio across countries, while relative contributions demand higher stock-to-use ratios in countries with higher variability in supply

relative contributions to the regional reserve. Nigeria, the single largest contributor, could save more than 300,000 metric tons of food when making relative as opposed to equal contribution. Similarly, Guinea, Cote d'Ivoire, Mali, and Cameroon would be able to reduce their contributions under the relative contribution scheme. In fact, the average stock-to-use ratio in the region (5 % for 95 % target consumption) represents a threshold. Without regional cooperation, all countries that have a stock-to-use ratio above the regional average are better off by adopting equal instead of relative contributions, while all countries with a stock-to-use ratio below regional average would prefer relative contributions.

For clarity, the tabulated results for the other target consumption levels are only presented in the appendix. However, their effect on total regional stocks is illustrated in Fig. 15.4. The benefits of cooperation are lower at higher levels of target consumption. At 99 % and 97 % target consumption, regional stocks were, respectively, around 25 % and 30 % lower with cooperation than without cooperation, whereas the benefits of cooperation are greater at the target consumption of 90 %. Accordingly, regional stocks could be 62 % lower with regional cooperation in contrast with without cooperation.

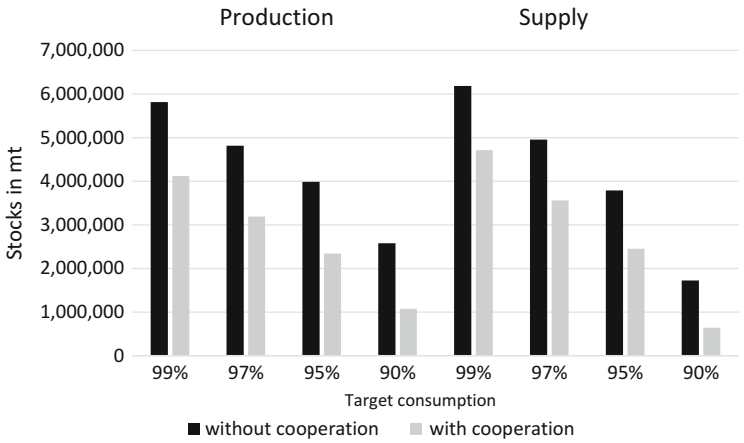

Fig. 15.4 Regional stocks with and without storage cooperation (without intra-regional trade). *Source*: Author's illustration based on USDA (2014)

It is noteworthy that a regional reserve without integration of markets or transfers between countries is required to act significantly more often than a national reserve as the probability of shortfalls increases. Hence, the total quantity needed to compensate for production and supply shortfalls is equal with or without storage cooperation. The benefits of cooperation are apparent only when lower stock levels are kept at any one time. However, these benefits are substantial as countries are also required to renew their reserve stocks on a regular basis, even if the reserve stocks are not used to offset supply shocks.

Lastly, what are the welfare implications that can be derived from the simulation results above? First and foremost, with reasonably high levels of target consumption, optimal stocking norms can be defined so that all countries would benefit from the decision. However, preferences are not homogeneous, and low levels of target consumption put countries with low supply variability at a disadvantage. Since the preferences of countries cannot be observed, only under two circumstances can net benefits be identified when preferences are heterogeneous. First, target consumption chosen by the region is lower than that of a country without cooperation, while stocking norms are lower with cooperation; in this case, a country benefits from cooperation. Second, the net benefits of cooperation are unambiguously negative if target consumption with cooperation is higher than with regional cooperation and if stocking norms are higher than without cooperation. Indeed, the latter can be excluded by choosing target consumption levels above 90 %. Intuitively, countries with large supply variability would likely prefer equal contribution to the regional reserve. Therefore, it is important to offer incentives for all countries to participate in the reserve in order to realize the full benefits of cooperation.

15.5.3 Emergency Reserve with Intra-Regional Trade

When intra-regional trade is allowed, the analysis is analogous to the scenario without trade. Therefore, the largest historical shortfalls and the associated stocking norms in autarky remain unchanged. The only difference is that supply shortfalls in neighboring countries are first alleviated through trade before releasing stocks from the reserve. Participating countries are committed to export only when actual supply exceeds estimated supply as computed by the HP-filter.

Figure 15.5 shows a comparison of the required stocks with and without intra-regional trade. Trade appears to hardly reduce the level of required stocks. The most notable gains are seen when stocks are based on a consumption shortfall of 10 %.

The results of the simulation can be explained by the choice of the criterion used to determine reserve levels according to historical consumption shortfalls. The historically largest shortfall occurred in 2007, and only very few countries were able to export in that year. The exports from these very few countries are not high enough to offset the supply shortfalls of other countries. Small differences in the reserve level notwithstanding, regional trade would reduce the frequency of stock-outs significantly. The probability of a shortfall occurring is at most 43 %, compared to between 89 % and 100 % across all levels of target consumption for the emergency reserve without intra-regional trade. When 5 % shortfall in consumption is allowed, with intra-regional trade, the probability of a shortfall is only between 20 % and 26 % for supply and production, respectively.

These benefits are founded on intra-regional exports. Figure 15.6 shows the average annual exports, based on production and supply figures, over the period

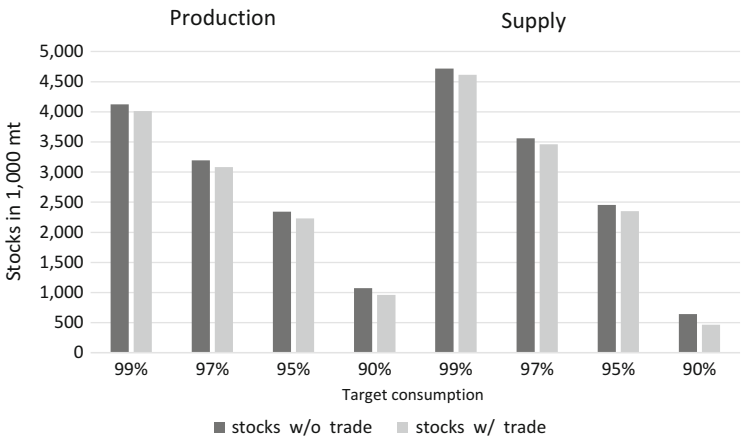

Fig. 15.5 Regional stocks for an emergency reserve with intra-regional trade. *Source*: Author's illustration based on USDA (2014)

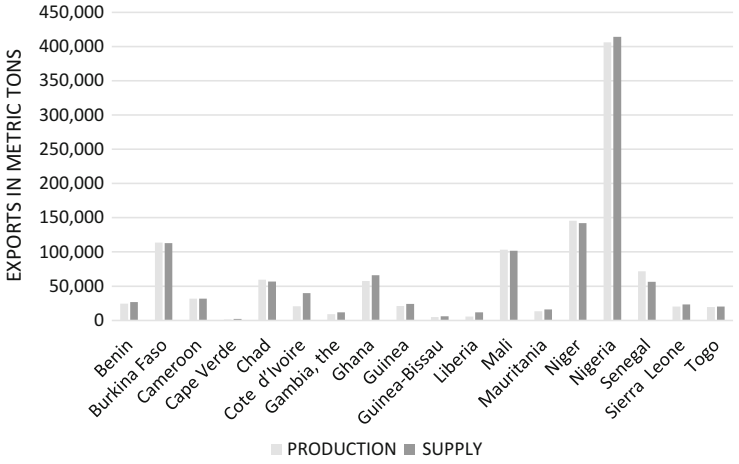

Fig. 15.6 Average annual exports by country 1980–2014. *Source*: Author's illustration based on USDA (2014)

from 1980 to 2014. The total annual exports amounted to 1.13 million tons based on production and 1.16 million tons based on supply data. As calculated using the expected supply for 2014, the total annual exports range between 0.7 % and 0.9 % of total supply in 2014 for Guinea and Cameroon and between 4.59 % and 7.9 % for Cape Verde. By the definition used to determine exports, countries with higher production and supply fluctuations automatically export more than countries with lower fluctuations. This is because these countries exhibit greater positive and negative deviations from the trend. Generally, exports are at a realistic level. Net welfare benefits can be computed in a way similar to the case without intra-regional trade.

15.5.4 Stabilization Reserve

The optimal stocking rule under national stockholding can be estimated using actual stock data. Since the USDA only has poor quality of data on stocks for small countries, the FAO CBS stock data is preferred and utilized in this analysis. The stocking parameter is obtained by estimating the following equation with OLS:

$$S_t = \gamma \ (S_{t-1} + Q_{t-1} + \mathrm{IM}_{t-1} - \mathrm{EX}_{t-1}) + \varepsilon_t \tag{15.24}$$

where all variables are as described in the previous sections and ε_t is the normally distributed error term.

It should be noted that the constant is omitted in this estimation. First, storage is a nonnegative value, and negative stocks values are also impossible. Second, stocks

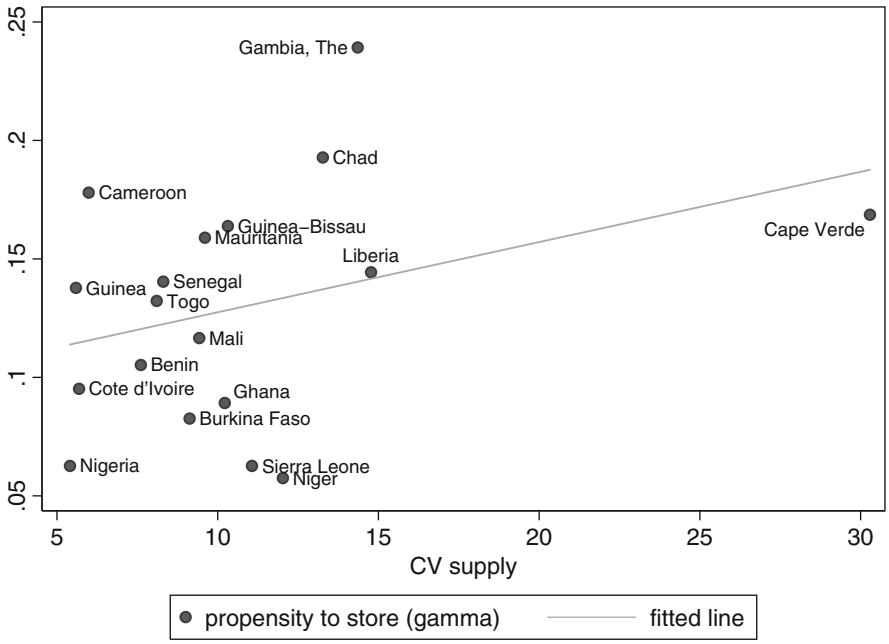

Fig. 15.7 Stocking parameter and supply variability across study countries. *Source*: Author's illustration based on USDA (2014) and FAO CBS (2014)

need to increase with supply starting from zero if supply is zero.[10] The results are presented in Fig. 15.7, which depicts the stocking parameter γ conditional on the level of supply variability estimated by the coefficient of variation around a trend as described in the previous sections.

The solid line represents the overall positive correlation between supply variability and the stocking rule. A slope parameter of 0.30 implies that the stocking parameter increases by 3 percentage points on average when supply variability is 10 percentage points higher.[11] However, there are notable exceptions to this relationship.[12] Niger, Sierra Leone, and Nigeria store only 6 % of its total available supply, although their supply variability is relatively high. In contrast, the Gambia and Chad experience supply variability similar to Niger, but they store 24 % and 19 %, respectively. All other countries in the region store roughly between 8 and

[10]The estimation is associated with several problems (non-stationarity, number of observations), and results have to be interpreted with caution. However, the objective is not to establish causality or to compute confidence intervals but rather to obtain a country's preferences without storage cooperation.

[11]When Cape Verde, an outlier, is excluded, the slope parameter only changes marginally.

[12]It should be noted that an increase of 0.1 is quite substantial because γ ranges between 0 and 1.

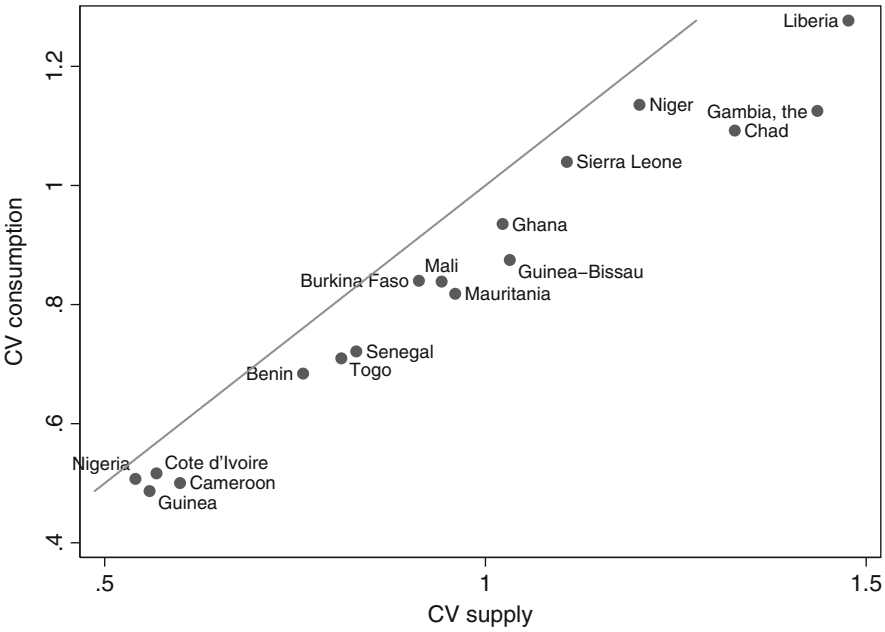

Fig. 15.8 Consumption and supply variability of study countries. *Source*: Author's illustration based on USDA (2014) and FAO CBS (2014)

17 %. Taking the sum of individual stocks as the optimal choice for the region, 9 % of the region's annual supply should be stored due to the low value of Nigeria.

Using the policy parameter and the information on each country's supply variability, it is possible to compute the consumption variability as chosen by each country (see Eq. 15.22). Figure 15.8 shows the relative position of each country with regard to their consumption and supply. The solid line represents the parity between consumption and supply variability; countries without storage would lie on this line. With additional storage, countries move further to the right, away from the solid line. Hence, the larger a country's stocking parameter γ is, the farther away from the parity line countries are. Moreover, for countries with lower supply variability, it is less efficient to decrease consumption variability by one unit by increasing storage. For example, Cameroon needs to store 18 % of its total available supply to reduce consumption variability by 1 %. In contrast, Ghana is able to reduce consumption instability by 0.8 % by storing only 9 % of its available supply.

The costs of stabilization are already described by the stocking parameter γ. The full dimension of the costs become more visible when looking at the amount of stocks required to reach a desired level of consumption stability. Table 15.5 presents the optimal stock levels and stock-to-use ratio for γ calculated using country-level stock data and compares them to actual levels. The resulting stock-to-use ratio is $\alpha = \frac{\gamma}{1-\gamma}$, which has a positive exponential relationship with γ. When $\gamma > 0.5$, stocks already amount to expected consumption levels with a stock-to-use ratio

Table 15.5 Actual and optimal stock levels under a linear stocking rule

	γ^*	CV_c	S^*	S_{2013}	α^*	$\frac{S_{2013}}{C}$
Benin	0.105	6.8	220,802	162,000	11.8	12.8
Burkina Faso	0.083	8.4	466,615	495,000	9.0	8.5
Cameroon	0.178	5.0	899,228	866,000	21.7	16.0
Cape Verde	0.169	25.5	5089	7000	20.3	20.3
Chad	0.193	10.9	496,928	564,000	23.9	22.3
Cote d'Ivoire	0.095	5.2	290,463	467,000	10.5	9.3
Gambia, The	0.239	11.2	107,609	48,000	31.5	30.4
Ghana	0.089	9.4	379,520	325,000	9.8	9.2
Guinea	0.138	4.9	438,248	511,000	16.0	14.3
Guinea-Bissau	0.164	8.7	59,828	69,500	19.6	17.3
Liberia	0.144	12.8	86,482	56,000	16.9	14.7
Mali	0.117	8.4	746,375	855,000	13.2	10.1
Mauritania	0.159	8.2	137,177	95,500	18.9	20.7
Niger	0.057	11.4	314,910	522,000	6.1	5.4
Nigeria	0.063	5.1	1,915,352	850,000	6.7	7.0
Senegal	0.140	7.2	491,235	492,000	16.3	16.2
Sierra Leone	0.063	10.4	72,532	87,000	6.7	5.3
Togo	0.132	7.1	211,342	171,000	15.2	14.9
Region	–	3.1	7,063,305	6,643,000	–	10.3

Source: Author's computation based on USDA (2014) and FAO CBS (2014). *Note*: Country level γ is obtained by the regression (15.24); CV consumption is computed as $CV_c = \sqrt{\frac{1-\gamma}{1+\gamma}}\, CV(X)$ (see Eq. 15.22); the optimal regional γ *i*s unknown

greater than one. Notably, the linear stocking rule predicts actual stocks and stock-to-use ratios quite precisely.

The last row in Table 15.5 provides stock figures for the region as a whole. Given the current stock level of around 7 million tons, the regional stocking rule would imply that 9 % of the total supply needs to be stocked up. This is associated with a consumption variability of 3.4 %, as compared to 3.1 % without storage. It is also possible to describe the initial optimization problem of governments directly as a trade-off between costs and benefits, more specifically, the trade-off between consumption stability and operational costs. Figure 15.9 shows the trade-off for the region as a whole. The dotted black line indicates the status quo – roughly 7 million tons of stocks associated with a coefficient of variation of consumption of 3.1 %. The dashed black line represents a stock level of 11.1 million tons resulting from a stocking parameter of 0.135, which is the median parameter across all member countries.

The required amount of stocks increases overproportionally with a reduction in consumption instability. In order to reach consumption stability of up to only 2.7 %, the region would require roughly 20 million tons of stocks. When no stocks are required however, consumption variability through market integration or transfers between countries is only 3.4 %; this figure is 2 % less for Nigeria, which has

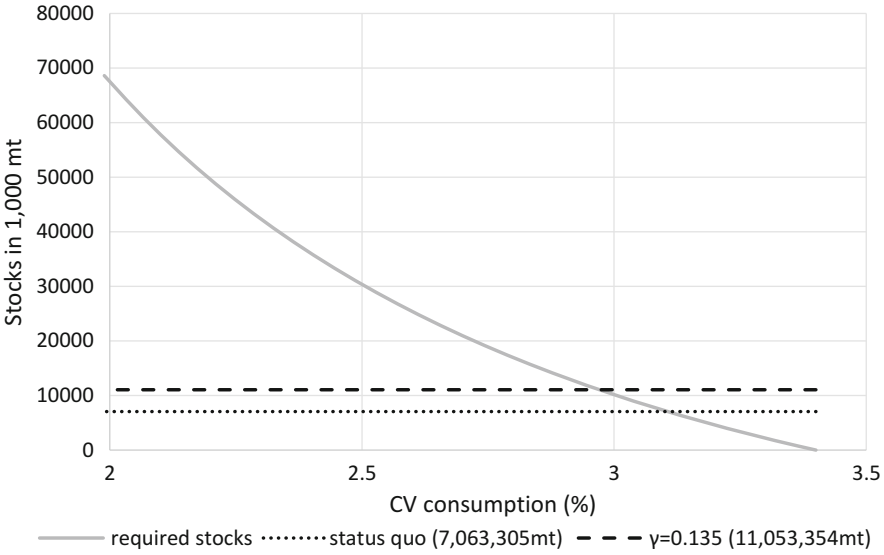

Fig. 15.9 Regional consumption variability at different stock levels. *Source*: Author's illustration based on USDA (2014) and FAO CBS (2014)

the lowest supply variability. This implies that most of the gains originate from trade integration and not from storage cooperation. In other words, consumption stability is largely enhanced by regional trade integration, but increasing stocks have only very little impact on the level of consumption variability. The benefits of regional trade cooperation are significant. Individual countries would need an unrealistically large amount of stocks in their stabilization reserve to achieve a consumption variability of 3.4 %. The costs and benefits of cooperation can be evaluated for a particular level of consumption variability which the region desires. We assume the observed stocking parameter is chosen as the optimal stocking rule by each country. Since trade integration is associated with huge benefits in the form of a reduction of consumption instability, a country in autarky may be worse off only if the regional stocking parameter exceeds the one chosen by the country. Hence, net benefits are strictly positive for all countries up to a stock-to-use ratio of 6.1 % for Niger, 6.7 % for Nigeria and Sierra Leone, 9.0 % for Burkina Faso, and 9.8 % for Ghana; in the same manner, the values for other countries are determined according to α_i^*, as shown in Table 15.5.

Lastly, it is possible to test how a linear stocking rule would have performed over the course of the last 35 years. Figure 15.10 illustrates the performance in relation to the associated target consumption levels. Despite regional trade integration, the simulated regional consumption undershot target consumption levels of 99 %, 97 %,

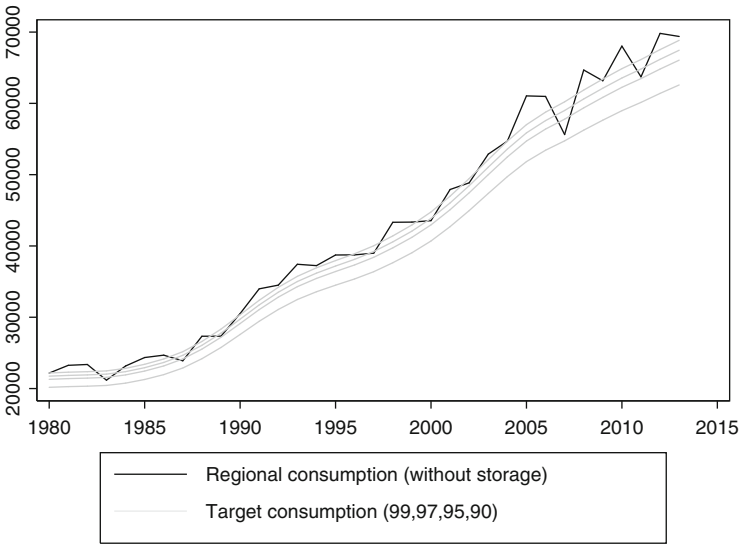

Fig. 15.10 Regional consumption under trade integration without storage. *Source*: Author's illustration based on USDA (2014) and FAO CBS (2014)

and 95 % multiple times.[13] Thus, regional trade integration reduces consumption variability significantly, but it is unable to combat severe supply shortfalls. Conversely, a linear stocking rule which guarantees that all countries achieve net benefits by cooperating ($\alpha = 6.1$ %) would have a guaranteed target consumption of 97 % over the whole period. Clearly, a linear stocking rule is effective in buffering positive and negative supply shock. However, the effects are rather small compared with the benefits of trade integration within the whole region. This may change if the number of participating countries reduces.

15.6 Conclusion

In this study, a methodology for assessing the costs and benefits of regional storage cooperation is outlined and applied to the West African region. Building on the influential works of Johnson (1976) and Koester (1986), the methodology establishes a link between supply and consumption variability, and it accounts for the potential benefits of cooperation through the imperfect correlation of production and supply shocks among neighboring countries. In doing so, the work complements previous studies by conceptualizing the link to storage.

[13]To be exact, the number of shortfalls are (accordingly to target consumption) 99 %, 11 times; 97 %, 7 times; 95 %, 3 times; and 90 %, never.

The principles of risk pooling allow for reducing carry-over stocks by 35–41 % within West Africa without welfare transfers or trade between countries so as to guarantee at least 95 % of the expected trend consumption. For other minimum consumption levels, the benefits are between 25 % and 60 %. National contributions to the reserve can be organized in such a manner that all countries benefit significantly from the cooperation. However, in this way, releases from the reserve would occur frequently, and stocks would need to be refilled on a regular basis. If limited intra-regional trade takes place between areas with surplus and deficiency, the optimal regional stocks under cooperation hardly change. However, the need for stock release intervention reduces significantly. Therefore, trade is very effective in smoothing consumption when supply fluctuations are moderate. In contrast, reserves are required to dampen large supply shortfalls. These benefits are large enough to justify additional costs that may arise from storage cooperation. Lastly, complete market integration in West Africa would greatly benefit countries with high supply variability. Without undertaking any storage, regional supply variability is at 3.4 %, which is higher than that of each country included in the analysis. Storage cooperation beyond full market integration would reduce consumption variability only marginally. Furthermore, trade integration without storage, unlike an emergency reserve, is incapable of dampening severe supply shortfalls.

It is also important to consider offering incentives to countries to encourage them to participate in a regional reserve. When the level of target consumption is relatively low in an emergency reserve, countries with low supply variability do not benefit. Yet these countries are of particular importance to realize the full benefits of regional cooperation. The advantages of cooperation diminish rapidly when countries with limited supply variability or countercyclical shock patterns refuse to participate in the alliance. However, it should be noted that a regional emergency reserve guaranteeing relative high levels of target consumption needs to carry large amounts of stocks, which are associated with high operational costs.

These findings are of great relevance to the ongoing debate on public food storage, trade integration, and regional reserves. Trade liberalization is widely considered as an effective instrument to balance supply variability and production shortfalls. In contrast, public storage is associated with substantial market distortions and comes at high fiscal costs. Nevertheless, a number of developing countries responded to the global food crisis in 2007/2008 by implementing and enhancing public storage to increase food security. This is also driven by the unpredictability of food availability at international markets as exporters attempt to insulate domestic markets. Regional storage cooperation was brought up for discussion as viable and comparably cheap means of addressing a food crisis and as an alternative to national reserves. Moreover, storage cooperation could enhance commitment of exporters to regional trade agreements (Wright and Cafiero 2011).

West Africa has taken a pioneering role by showing the intention to implement a region-wide emergency reserve. Political and economic integration in West Africa is among the most advanced in Africa. However, at present, intra-regional trade is limited partly because of bad infrastructure and bureaucratic hindrances at national boundaries. The results from this study should be understood as an encouragement to regional storage cooperation in the region. Three messages can be taken away from this study. First, production and supply patterns in the region are able to facilitate cooperation which may yield massive benefits. Second, trade integration is more effective than storage in smoothing supply, but storage is required to dampen extreme supply shortfalls. Last, there is great potential for storage cooperation with regard to an emergency reserve and less with regard to a stabilization reserve. Nevertheless, clear rules about individual country's contributions and releases, and, if needed, regional trade management, are essential to organize regional storage with mutual benefits. Administrative complexity is likely to be a smaller problem with a limited number of partner countries. Therefore, future research should attempt to evaluate the costs and benefits for subsets of countries in an attempt to identify the countries which could possibly form a coalition. Moreover, the potential benefit of intra-regional trade integration should be analyzed more rigorously.

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Appendix

Table 15.6 Optimal stock levels in 2014 for target consumption of 99 %

	Production				Supply			
	P_i	S_i^*	$\widehat{S}_i$	$\widetilde{S}_i$	P_i	S_i^*	$\widehat{S}_i$	$\widetilde{S}_i$
Benin	40 %	141,604	120,137	100,356	37 %	152,677	127,265	116,424
Burkina Faso	40 %	631,234	368,174	447,361	40 %	593,667	351,453	452,700
Cameroon	49 %	214,049	236,879	151,698	26 %	203,148	281,713	154,911
Cape Verde	49 %	8101	524	5741	52 %	15,455	1701	11,785
Chad	49 %	368,209	139,960	260,953	46 %	357,082	141,125	272,293
Cote d'Ivoire	37 %	127,531	97,789	90,382	43 %	181,273	187,327	138,229
Gambia, The	43 %	79,208	16,839	56,135	55 %	48,382	23,208	36,894
Ghana	43 %	357,196	207,853	253,148	43 %	477,451	263,042	364,079
Guinea	43 %	90,030	174,930	63,805	46 %	124,296	186,109	94,782
Guinea-Bissau	43 %	26,771	13,318	18,973	46 %	26,092	20,706	19,896
Liberia	40 %	27,477	13,978	19,473	49 %	53,601	34,774	40,873
Mali	58 %	419,760	429,367	297,487	55 %	417,047	383,615	318,019

(continued)

Table 15.6 (continued)

	Production				Supply			
	P_i	S_i^*	$\widehat{S}_i$	$\widetilde{S}_i$	P_i	S_i^*	$\widehat{S}_i$	$\widetilde{S}_i$
Mauritania	49 %	56,683	16,814	40,172	46 %	111,038	49,237	84,672
Niger	37 %	779,525	360,017	552,456	37 %	681,052	350,313	519,335
Nigeria	43 %	1,786,527	1,674,944	1,266,127	43 %	2,167,705	1,943,323	1,652,981
Senegal	49 %	477,554	100,173	338,447	52 %	308,029	204,087	234,887
Sierra Leone	37 %	128,728	62,996	91,231	46 %	149,723	73,652	114,171
Togo	43 %	95,910	87,226	67,972	40 %	117,762	94,081	89,800
Region	100 %	5,816,099	4,122,000	4,122,000	100 %	6,185,480	4,716,730	4,716,730

Source: Author's computation based on USDA (2014). *Note*: Stock levels in mt; P_i is the probability of intervention when production and supply are below the target consumption (99 %). S_i^*, $\widehat{S}_i$, $\widetilde{S}_i$ are stocks without cooperation and with equal and relative contributions

Table 15.7 Optimal stock levels in 2014 for target consumption of 97 %

	Production				Supply			
	P_i	S_i^*	$\widehat{S}_i$	$\widetilde{S}_i$	P_i	S_i^*	$\widehat{S}_i$	$\widetilde{S}_i$
Benin	34 %	120,218	93,057	79,668	37 %	127,936	96,089	91,907
Burkina Faso	34 %	546,502	285,182	362,163	37 %	500,825	265,358	359,785
Cameroon	29 %	189,018	183,483	125,260	17 %	170,363	212,702	122,386
Cape Verde	49 %	7836	406	5193	40 %	14,800	1285	10,632
Chad	43 %	334,871	108,411	221,916	40 %	317,808	106,554	228,308
Cote d'Ivoire	23 %	106,025	75,746	70,262	31 %	139,631	141,438	100,309
Gambia, The	37 %	74,719	13,043	49,515	54 %	41,486	17,523	29,803
Ghana	37 %	317,677	161,000	210,522	34 %	422,149	198,605	303,265
Guinea	34 %	74,009	135,498	49,045	31 %	87,947	140,519	63,179
Guinea-Bissau	34 %	24,150	10,316	16,004	40 %	23,423	15,634	16,827
Liberia	40 %	23,892	10,827	15,833	37 %	48,902	26,255	35,130
Mali	46 %	309,623	332,581	205,185	49 %	303,936	289,642	218,342
Mauritania	49 %	53,175	13,024	35,238	37 %	101,159	37,175	72,671
Niger	34 %	693,576	278,864	459,627	34 %	585,455	264,498	420,581
Nigeria	34 %	1,285,869	1,297,387	852,134	34 %	1,572,822	1,467,271	1,129,890
Senegal	43 %	453,584	77,593	300,586	43 %	258,230	154,092	185,508
Sierra Leone	34 %	117,360	48,796	77,773	40 %	134,597	55,609	96,692
Togo	31 %	85,791	67,564	56,853	29 %	105,888	71,035	76,069
Region	100 %	4,817,894	3,193,000	3,193,000	97 %	4,957,355	3,561,283	3,561,283

Source: Author's computation based on USDA (2014). *Note*: Stock levels in mt; P_i is the probability of intervention when production and supply are below the target consumption (99 %). S_i^*, $\widehat{S}_i$, $\widetilde{S}_i$ are stocks without cooperation and with equal and relative contributions

Table 15.8 Optimal stock levels in 2014 for target consumption of 90 %

	Production				Supply			
	P_i	S_i^*	$\widehat{S}_i$	$\widetilde{S}_i$	P_i	S_i^*	$\widehat{S}_i$	$\widetilde{S}_i$
Benin	11 %	49,479	31,300	20,578	11 %	42,379	17,315	15,755
Burkina Faso	23 %	271,876	95,923	113,071	20 %	203,667	47,818	75,717
Cameroon	9 %	101,408	61,716	42,175	9 %	94,852	38,329	35,263
Cape Verde	34 %	6910	137	2874	34 %	12,505	231	4649
Chad	23 %	218,190	36,465	90,743	23 %	180,347	19,201	67,048
Cote d'Ivoire	6 %	30,755	25,478	12,791	3 %	35,635	25,487	13,248
Gambia, The	29 %	59,007	4387	24,540	31 %	22,209	3158	8257
Ghana	14 %	257,176	54,153	106,957	11 %	228,592	35,789	84,984
Guinea	6 %	17,936	45,576	7460	6 %	10,864	25,322	4039
Guinea-Bissau	17 %	14,974	3470	6227	14 %	14,084	2817	5236
Liberia	26 %	15,564	3642	6473	23 %	32,455	4731	12,066
Mali	11 %	110,280	111,866	45,864	14 %	78,210	52,194	29,076
Mauritania	37 %	40,894	4381	17,007	17 %	66,580	6699	24,753
Niger	20 %	392,751	93,798	163,341	20 %	345,241	47,663	128,351
Nigeria	3 %	497,369	436,384	206,851	9 %	128,646	264,404	47,827
Senegal	29 %	369,686	26,099	153,749	9 %	83,935	27,768	31,205
Sierra Leone	23 %	77,571	16,413	32,261	20 %	81,657	10,021	30,358
Togo	14 %	50,373	22,726	20,950	11 %	64,329	12,800	23,916
Region	89 %	2,582,200	1,074,000	1,074,000	89 %	1,726,187	641,747	641,747

Source: Author's computation based on USDA (2014). *Note*: Stock levels in mt; P_i is the probability of intervention when production and supply are below the target consumption (99 %). S_i^*, $\widehat{S}_i$, $\widetilde{S}_i$ are stocks without cooperation and with equal and relative contributions

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Regional Trade and Volatility in Staple Food Markets in Africa

16

Ousmane Badiane and Sunday Odjo

16.1 Introduction

Recent studies have indicated that Africa as a whole and a number of individual countries have exhibited relatively strong trade performance in the global market (Bouët et al. 2014) as well as in continental and major regional markets (Badiane et al. 2014). The increased competitiveness has generally translated into higher shares of regional markets in total exports by the different groupings. Faster growth in demand in continental and regional markets compared to the global market has also boosted the export performance of African countries. For instance, during the second half of the last decade, Africa's share of the global export market has risen sharply, in relative terms, for all goods and agricultural products in value terms, from 0.05 to 0.21 % and from 0.15 to 0.34 %, respectively. This is in line with the stronger competitive position of African exporters mentioned earlier.

By promoting competition and specialization in production, regional trade–similar to global trade–can contribute to food security through its impact on long-term output and productivity growth. At the same time, it can positively affect employment and incomes. Where these effects are positive, trade increases the availability of food and improves the accessibility of food to affected segments of the population. Trade also helps reduce the unit cost of supplying food to local markets, thereby lowering food prices or reducing the pace of food price increase, which in turn improves the affordability of food. Finally, trade can also help stabilize supplies in domestic food markets and reduce the associated risks to vulnerable groups.

All of the above-mentioned benefits can be obtained, perhaps to a larger extent, through trading with the rest of the world. For instance, one could question why a

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given country should pursue an expansion of regional trade as opposed to global trade in general for stabilizing domestic food supplies, given that world production can be expected to be more stable than regional production. Several factors, such as transport costs, foreign exchange availability, responsiveness of the import sector, and dietary preferences, may provide valid economic justification for a country's efforts to boost regional trade as part of a wider supply stabilization strategy that would also include increased trade with extra-regional markets. Regional and global trade should therefore be seen as complementary rather than as substitutes.

The increase in intra-African and intra-regional trade, and the rising role of continental and regional markets as major destinations of agricultural exports by African countries suggest that cross-border trade flows will exert greater influence on the level and stability of domestic food supplies. The more countries find ways to accelerate the pace of intra-trade growth, the larger that influence is expected to be in the future. The current chapter examines the future outlook for intra-regional trade expansion and the implications for volatility of regional food markets. The chapter starts with an analysis of the potential of regional trade to contribute to stabilizing food markets, followed by an assessment of the scope for cross-border trade expansion. A regional trade simulation model is then developed and used to simulate alternative scenarios to boost trade and reduce volatility in regional markets.

16.2 Regional Potential for the Stabilization of Domestic Food Markets Through Trade

Variability of domestic production is a major contributor to local food price instability in low income countries. The causes of production variability are such that an entire region is less likely to be affected than individual countries. Moreover, fluctuations in national production tend to partially offset each other, so that such fluctuations are less than perfectly correlated. Food production can be expected to be more stable at regional level than at country level. In this case, expanding cross-border trade and allowing greater integration of domestic food markets would reduce supply volatility and price instability in these markets. Integrating regional markets through increased trade raises the capacity of domestic markets to absorb local price risks by: (1) enlarging the area of production and consumption and thus increasing the volume of demand and supply that can be adjusted to respond to and dampen the effects of shocks; (2) providing incentives to invest in marketing services and expand capacities and activities in the marketing sector, which raises the capacity of the private sector to respond to future shocks; and (3) lowering the size of needed carryover stocks, thereby reducing the cost of supplying markets during periods of shortage and hence decreasing the likely amplitude of price variation.

A simple comparison of the cereal production variability in individual countries against the regional average is carried out to illustrate the potential for local market stabilization through greater market integration (Badiane 1988). For that purpose, a

trend-corrected coefficient of variation is used as a measure of production variability at both country and regional levels. We then use a normalization procedure whereby the value of the coefficient for each country is divided by the value of the coefficient for the corresponding region. Calculations are carried out for each of the three regional economic groupings (as mentioned above), and the results are presented in Table 16.6 in the annex and plotted in Fig. 16.1a–c below. The bars in the figures represent the normalized coefficients of variation, which indicate how much more (when normalized coefficient are greater than 1) or less (when normalized coefficient are less than 1) volatile a country's production is when compared with production at the level of their respective region.

Of the three regions, SADC has the highest level of aggregate volatility with a coefficient of variation of 18.58 or more than two and three times that of ECOWAS and COMESA, respectively. For the vast majority of countries, national production volatility is considerably larger than regional level volatility. The only exceptions are the Democratic Republic of Congo (DRC) in SADC and to a lesser extent Côte d'Ivoire in ECOWAS. None of the COMESA countries has a more stable production than the regional aggregate. The COMESA countries can be divided into two subgroups: (1) a relatively low volatility subgroup with normalized coefficients of less than twice the regional average, including Burundi, Comoros, DRC, Egypt, and Uganda and (2) a high volatility regional subgroup with volatility levels that are at least five times higher than the regional level, comprising Malawi, Mauritius,[1] Rwanda, Sudan, Swaziland, Zambia, and Zimbabwe. Kenya and Madagascar both have moderate levels of volatility and fall between the two groups. Most countries in SADC and ECOWAS are in the moderate regional category, with only Botswana and Mauritius (in SADC), and Gambia, Liberia, Mali, and Senegal (in ECOWAS) showing volatility levels more than three times higher than the respective regional levels. The countries in the moderate- and high-volatility subgroups would benefit the most from increased regional trade in terms of greater stability of domestic supplies.

The likelihood that a given country would benefit from the trade stabilization potential, as suggested by the difference between its volatility level and the regional average, will be greater if its production fluctuates more and is weakly correlated with that of the other countries in the region. Figure 16.2 presents the distribution of correlation coefficients between individual country's production levels for each regional group. For each country, the lower segment of the bar shows the percentage of correlation coefficients that are 0.65 or less or the share of countries with production fluctuations that are defined as relatively weakly correlated with the country's own production movements. The top segment represents the share of countries with highly correlated production fluctuations, with coefficients that are higher than 0.75. The middle segment is the share of moderately correlated country productions, with coefficients that are between 0.65 and 0.75.

[1] Mauritius has a coefficient that is more than 18 times the regional average and is not shown in the figure for clarity.

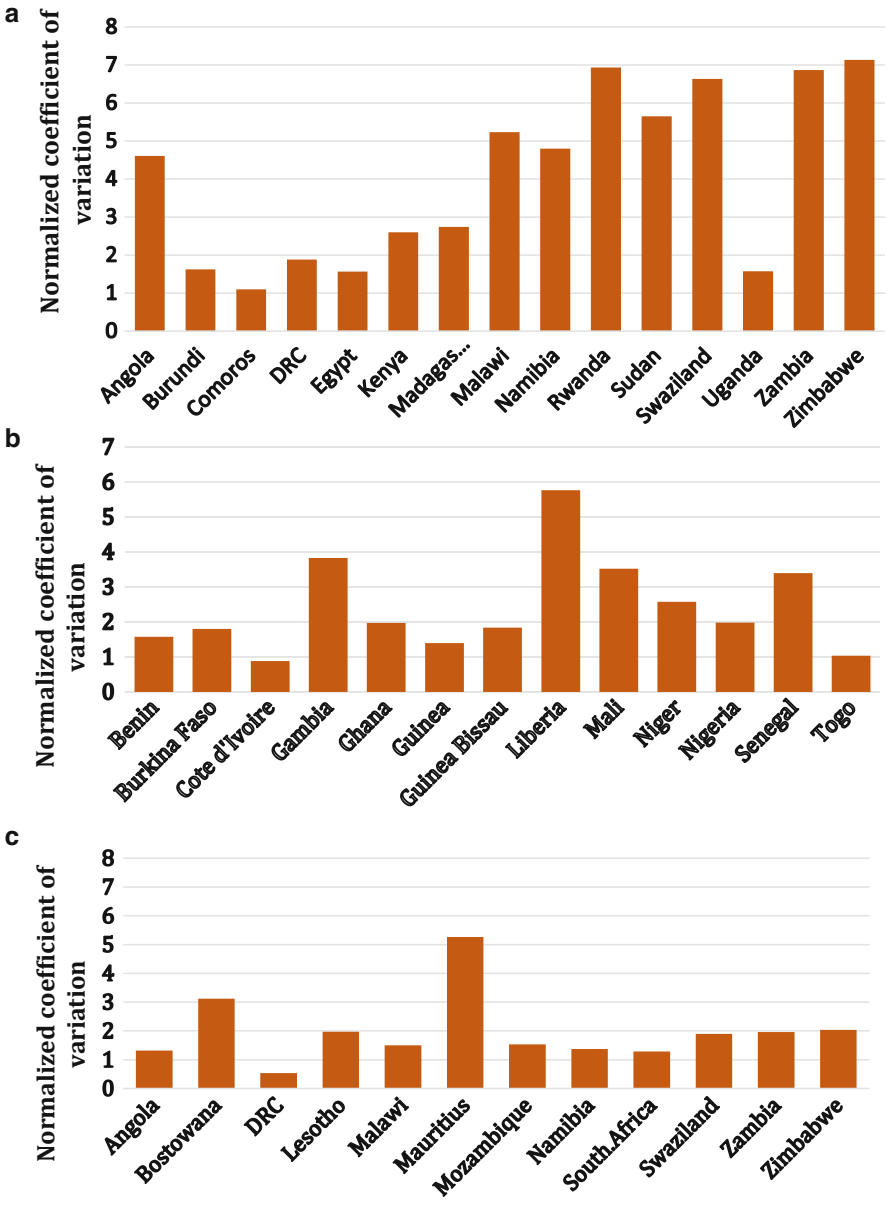

Fig. 16.1 (**a**) COMESA cereal production instability, 1980–2010. (**b**) ECOWAS cereal production instability. (**c**) SADC cereal production instability. *Source*: Authors' calculation. All graphs based on FAOSTAT 2014 data from 1980 to 2010

Using the above criteria, countries in the most volatile region, SADC, have the highest concentration of weakly correlated country production levels. As shown

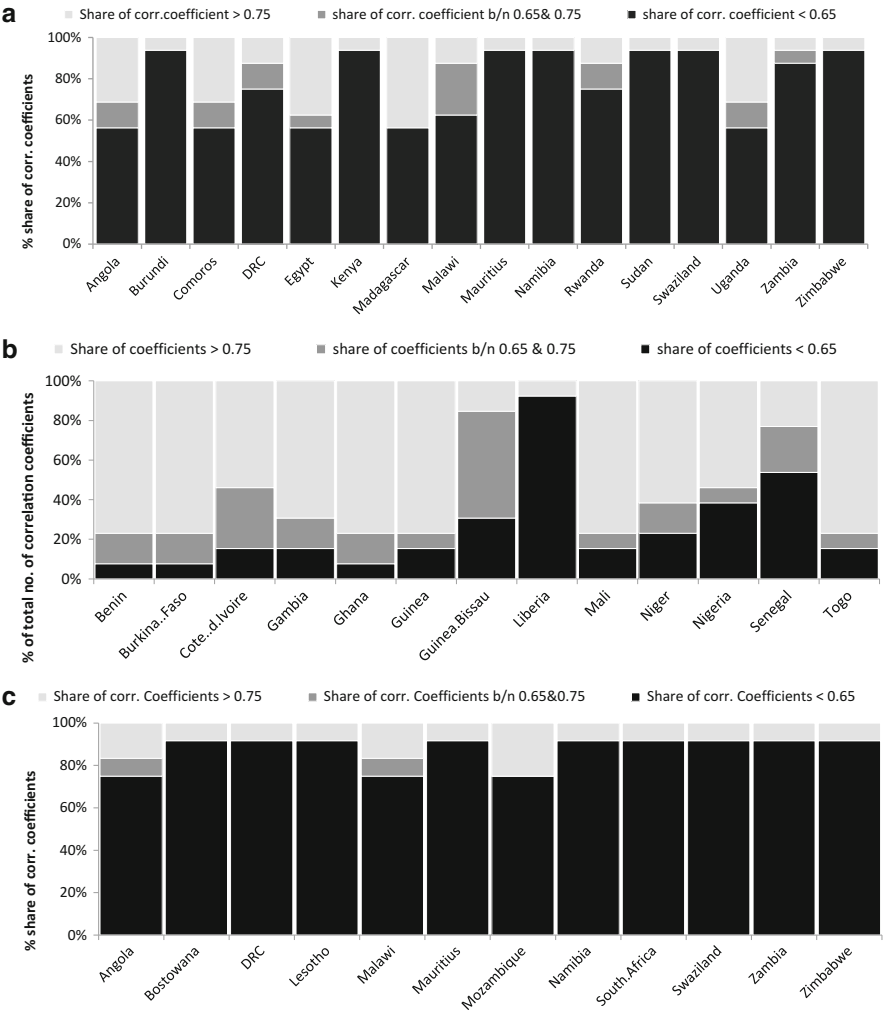

Fig. 16.2 (**a**) Distribution of correlation coefficients, COMESA. (**b**) Distribution of correlation coefficients, ECOWAS. (**c**) Distribution of correlation coefficients, SADC. *Source*: Authors' calculation. All graphs based on FAOSTAT 2014 data from 1980 to 2010

in Fig. 16.2c, only three countries have less than an 80 % share of correlation coefficients below 0.65. The combination of high volatility and weak correlation suggests that countries in this region would benefit the most from increased regional trade in terms of domestic market stabilization. They are followed by COMESA countries, where 60 % of the correlation coefficients for any given country are below 0.65. In contrast, country-level production levels in the ECOWAS region tend to fluctuate more together than the other two regions, as shown by the high share of coefficients above 0.75. The division of the region into two nearly uniform

subregions, Sahelian and coastal, may be an explanation. In general, however, the patterns and distribution of production fluctuations among countries in all the three regions are such that increased trade could be expected to have a stabilizing effect on domestic agricultural and food markets. But that is only one condition; the other is that there is actual potential to increase cross-border trade, a question that will be examined in the next section.

16.3 The Scope for Specialization and Regional Trade Expansion in Agriculture

Despite the recent upward trends, the level of intra-African and intra-regional trade is still very low compared with other regions. Intra-African markets accounted only for an average 34 % of the total agricultural exports from African countries between 2007 and 2011 (Badiane et al. 2014). Among the three RECs, SADC had the highest share of intra-regional trade (42 %), and ECOWAS the lowest (6 %). COMESA's share of intra-regional trade was 20 %. Although SADC is doing much better than the other two RECs, its member countries still account for far less than half of the value of agricultural trade within the region (Badiane et al. 2014).

There may be a host of factors behind the low levels of intra-regional trade. These factors may not only make trading with extra-regional partners more attractive, but they may also raise the cost of supplying regional markets from intra-regional sources. The exploitation of the regional stabilization potential, as pointed out above, would require measures to lower the barriers to and the bias against transborder trade such as to stimulate the expansion of regional supply capacities and of trade flows across borders. This supposes that there is sufficient scope for specialization in production and trade within the subregions. Often, it is assumed that neighboring developing countries would exhibit similar production and trading patterns because of the similarities in their resource bases, leaving little room for future specialization. There are, however, several factors that may lead to different specialization patterns among such countries. These factors include (1) differences in historical technological investments and thus the level and structure of accumulated production capacities and skills; (2) the economic distance to, and opportunity to trade with, distant markets; and (3) differences in dietary patterns as well as consumer preferences that affect the structure of local production. The different patterns of specialization in Senegal compared with the rest of Sahelian West Africa and in Kenya compared with other Eastern African countries well illustrate the influence of these factors.

Consequently, we use a series of indicators to assess the actual degree of specialization in agricultural production and trade, and whether there is real scope for transborder trade expansion as a strategy to exploit the less-than-perfect correlation between national productions to reduce the vulnerability of domestic food markets to shocks. The first two indicators are the production and export similarity indices, which measure and rank the relative importance of the production and trading of individual agricultural products in every country. The level of importance or position

of each product is then compared for all relevant pairs of countries within each subregion.[2] The indices have a maximum value of 100; an index value of 100 implies that the production or trade patterns between the considered pair of countries are completely similar. The closer the index value is to zero, the greater the degree of specialization between the two countries. Index values of around 50 and below are interpreted as indicating patterns of specialization that are compatible with higher degrees of trade expansion. The estimated indicator values for the three regional groupings, covering 150 products in total, are presented in Fig. 16.3a, b. Each bar represents the number of country pairs that falls within the corresponding range

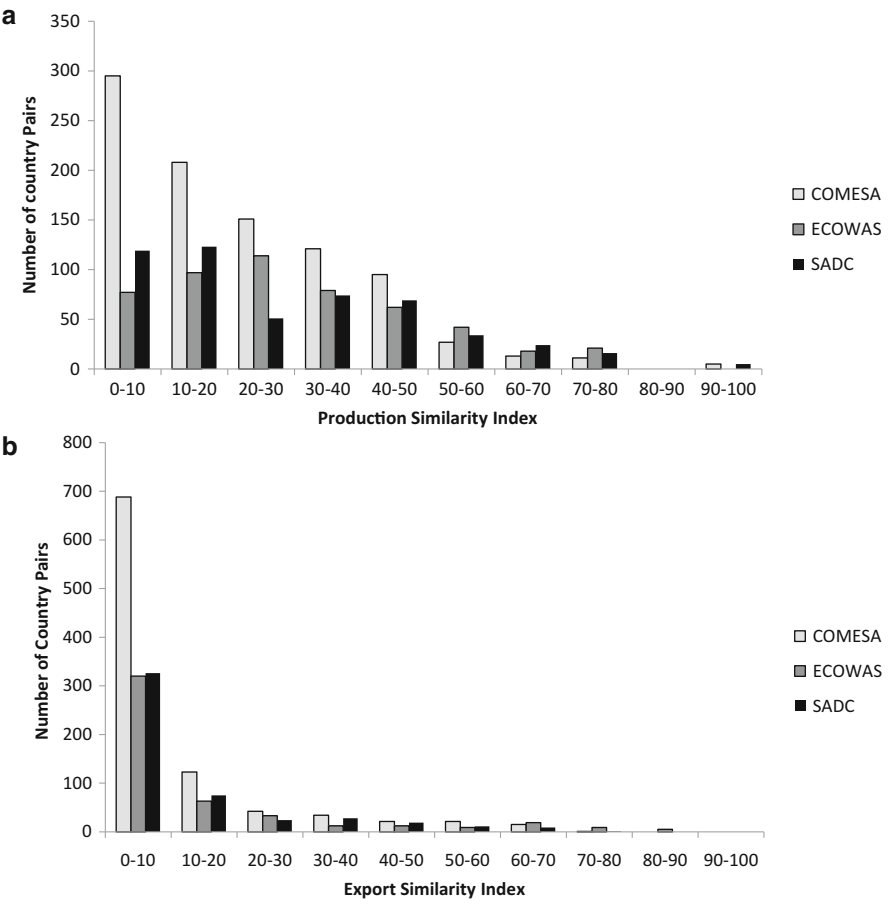

Fig. 16.3 (**a**) Similarity of production patterns, 2007–2011. *Source*: Authors' calculations based on data from FAOSTAT 2014. (**b**) Similarity of trading patterns, 2007–2011. *Source*: Authors' calculations based on data from FAOSTAT 2014

[2]See Koester (1986).

of index values. The vast majority of country pairs fall within the 0–50 range. A value of less than 60 is conventionally interpreted as compatible with higher trade exchange between the considered pair of countries. The estimated index values therefore suggest that there exists sufficient dissimilarity in the current production and trading patterns between countries and hence a scope for transborder trade expansion in all three subregions.

The third indicator, the revealed comparative advantage (RCA) index, is computed to further assess the degree of trade specialization among countries within the three regions. The RCA index compares the share of a given product in a given country's export basket with that of the same product in total world exports. A value greater than 1 indicates that the considered country is performing better than the world average; the higher the value is, the stronger the country's performance in exporting the considered product. Of the nearly 600 RCA indicators estimated for various products exported by different COMESA countries, 70 % have an index value higher than 1. ECOWAS and SADC each have a total of about 450 indicators. The share of indicators higher than 1 is about the same as in the case of COMESA: 68 % for SADC and 73 % for ECOWAS. For each regional grouping, the 20 products with the highest normalized RCA index value are presented in Table 16.1. The normalized RCA is positive for RCA indicators that are greater than 1 and negative otherwise.[3] For very high RCA indicators, the normalized value tends toward 1.

All the products listed in the table have normalized RCA values above 0.98. The rankings reflect the degree of cross-country specialization within each REC. In ECOWAS, for instance, a total of 12 products, spread across 8 out of 15 member countries, account for the highest 20 indicators for the region. There are 13 products in that category in the case of COMESA, and these products come from 9 out of 19 countries. SADC has the highest number of products in that category, a total of 14, but they come from only 5 out of 15 countries. The table also illustrates the difference in degree of specialization between the three major regions. Only two of the top ranking products (carded and combed cotton, and cashew nuts in shell) are common to the ECOWAS and SADC regions. Even between COMESA and SADC, only six of the top ranking products are common to the two regions, while there are no common top ranking products between COMESA and ECOWAS. A fuller appreciation of the degree of specialization across all countries in the three regions is best obtained by looking at the RCA values for the entire set of products and countries. For instance, if countries have similar patterns of specialization, the same products would tend to rank equally high and the values of the RCA indicator for the same product would not vary significantly across countries. Similarly, if countries have similar patterns of specialization, exports would be concentrated around a few products, with substantial variation of the indicator value across products. An analysis of the variance of the RCA index is, therefore, carried out to test for either of the above-mentioned possibilities. The results of the analysis, presented in Table 16.2, show that for the entire sample of African countries, nearly two-thirds

[3]The formula for the normalized RCA is $(RCA - 1)/(RCA + 1)$.

Table 16.1 Revealed comparative advantage indices by region, average 2007–2011

COMESA		ECOWAS		SADC	
Commodity	Country	Commodity	Country	Commodity	Country
Cloves	Comoros	Cashew nuts, with shell	Guinea Bissau	Vanilla	Madagascar
Vanilla	Comoros	Cake of groundnuts	Gambia	Cloves	Madagascar
Vanilla	Madagascar	Groundnut oil	Gambia	Coffee husks and skins	Tanzania
Coffee husks and skins	Uganda	Cashew nuts, with shell	Benin	Tobacco, unmanufactured	Malawi
Cloves	Madagascar	Groundnuts shelled	Gambia	Cotton carded, combed	Malawi
Oil essential nes	Comoros	Cashew nuts, with shell	Gambia	Cashew nuts, with shell	Tanzania
Coffee husks and skins	Burundi	Groundnut oil	Senegal	Cake of cottonseed	Zimbabwe
Sesame seed	Ethiopia	Copra	Gambia	Cake of cottonseed	Tanzania
Skins dry slt sheep	Ethiopia	Cake of groundnuts	Senegal	Cotton carded, combed	Tanzania
Coffee subst. cont. coffee	Rwanda	Cake of cottonseed	Benin	Cloves	Tanzania
Coffee husks and skins	Kenya	Rubber nat dry	Liberia	Coffee subst. cont. coffee	Malawi
Goat meat	Ethiopia	Cottonseed oil	Togo	Sesame oil	Tanzania
Cotton carded, combed	Uganda	Cottonseed oil	Benin	Cashew nuts, with shell	Mozambique
Sesame seed	Eriteria	Sugar beet	Gambia	Hides nes	Zimbabwe
Tobacco, unmanufactured	Malawi	Cashew nuts, with shell	Cote D'Ivoire	Cotton linter	Zimbabwe
Oilseeds, nes	Ethiopia	Cotton linter	Benin	Tobacco, unmanufactured	Zimbabwe
Broad beans, horse beans, dry	Ethiopia	Cocoa beans	Cote D'Ivoire	Cotton linter	Malawi
Cotton carded, combed	Burundi	Cake of Groundnuts	Togo	Tea	Malawi
Skinsdry sltsheep	Rwanda	Cocoa paste	Cote D'Ivoire	Cotton waste	Malawi
Tea	Rwanda	Cocoa beans	Ghana	Peas, green	Zimbabwe

Source: Authors' calculations based on FAOSTAT 2014

Table 16.2 Estimation of RCA variability across countries and products

Source of variance	Sequential sum of square	Mean squared	*F*	*P*-value	Share of variation explained
Model	1489.66	6.03	46.63	0.00	72.86 %
Country	936.94	23.42	181.09	0.00	45.82 %
Commodity	552.44	2.68	20.73	0.00	27.02 %
Year	0.28	0.28	2.19	0.14	0.01 %
Residual	555.03	0.129			27.14 %
Total	2044.69	0.45			
Number of obs.	4539	R^2 0.73	R^2 adj 0.71		

Note: The mean square (partial sum of squares/degrees of freedom) is used to compute the *F*-statistic and determine the significant amounts of variation. This ANOVA is without interaction terms due to the missing values from the unbalanced nature of the data. The time factor is included

(63 %) of the total variation of the RCA index among countries and commodities is accounted for by country-to-country variation. The balance of variation is explained by variation across products. The RCA index, like the previous two indicators, thus confirms the existence of dissimilar patterns of trade specialization in agricultural products.

So far, the analysis has established the existence of dissimilar patterns of specialization in production and trade of agricultural products among countries within and across the three major regions. Two final indicators, the Trade Overlap Indicator (TOI) and the Trade Expansion Indicator (TEI), are calculated to examine the potential to expand trade within the three blocks of countries based on current trade patterns.

The indicators measure how much of the same product a given country or region exports and imports at the same time. The TOI measures the overall degree of overlapping trade flows for a country or region as a whole, while the TEI measures the overlapping trade flows at the individual product level for a country or region. The results are presented in Fig. 16.4 and Table 16.3. The results indicate that there is a considerable degree of overlapping trade flows: 25 % for Africa as a whole and as much as 40 % for the SADC region. Normalized TOI values, obtained by dividing country TOI values by the TOI value, for the respective regions can be found in Badiane et al. (2014). In the vast majority of cases, they are significantly less than 1. The overlapping regional trade must therefore be taking place between different importing and exporting countries. In other words, some countries are exporting (importing) the same products that are being imported (exported) by other member countries in their respective grouping, but in both cases to and from countries outside the region. By redirecting such flows, countries should be able to expand transborder trade within their groupings.

The TEI indicates which products have the highest potential for increased transborder trade based on the degree of overlapping trade flows. Table 16.3 lists the 20 products with the highest TEI value for each of the three regions. The lowest TEI value for any of the products across the three regions is 0.41. RCA values

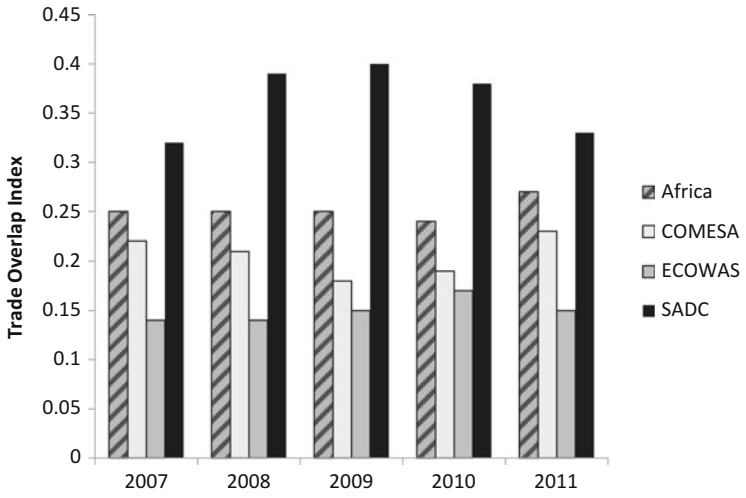

Fig. 16.4 Trade overlap indicators, average 2007–2011. *Source*: Authors' calculations based on FAOSTAT 2014

for the same products presented in Badiane et al. (2014) are all greater than 1, except for only three products: fresh fruits in ECOWAS, bananas in COMESA, and chocolate products in SADC. The fact that products with high TEI also have high RCA indicator values point to a real scope for transborder trade expansion in all three subregions.

The findings above indicate a real potential to expand intra-trade in all three regions beyond the levels shown in Table 16.1, even with current production and trade patterns. The remainder of the chapter therefore analyzes the outlook for intra-trade expansion and the expected impact of volatility of regional food markets over the next 15 years. This is done by simulating alternative policy scenarios to boost intra-regional trade and by comparing the resulting effect on the level and volatility of trade flows up to 2025 with outcomes simulated under a baseline scenario that assumes continuation of historical trends.

Table 16.3 Trade expansion indicators, average 2007–2011

COMESA		ECOWAS		SADC	
Commodity	TEI value	Commodity	TEI value	Commodity	TEI value
Beans, dry	0.825	Tobacco products	0.926	Pepper (piper spp.)	0.919
Sugar confectionery	0.821	Fatty acids	0.763	Cake, cottonseed	0.856
Vegetables, preserved	0.819	Groundnuts, shelled	0.744	Cottonseed	0.849
Juice, fruit	0.819	Hides, cattle, wet salted	0.681	Cigarettes	0.815
Cigarettes	0.782	Coffee, extracts	0.676	Hair, fine	0.811
Spices	0.716	*Fruit, fresh*	0.620	Bran, wheat	0.797
Sugar raw centrifugal	0.716	Fruit, tropical fresh	0.592	Waters, ice, etc.	0.783
Fruit, prepared	0.703	Cigarettes	0.573	Bran, maize	0.782
Groundnuts, shelled	0.700	Tea, mate extracts	0.535	Fruit, dried	0.776
Cake, cottonseed	0.680	Oilseeds	0.524	Sugar	0.774
Pineapples	0.677	Onions, dry	0.513	Cider, etc.	0.762
Cereal preparations	0.665	Oil, cottonseed	0.510	Molasses	0.759
Anise, badian, fennel, coriander	0.655	Pepper (piper spp.)	0.479	*Juice, fruit*	0.749
Waters, ice, etc.	0.655	Margarine short	0.456	Onions, dry	0.743
Cheese, whole cow milk	0.604	Roots and tubers	0.454	Flour, cereals	0.730
Bananas	0.592	Cereal preparations	0.439	*Chocolate products*	0.723
Bran, wheat	0.586	Chickpeas	0.415	Meat, pig, preparations	0.715
Tobacco products	0.586	Vegetables fresh or dried products	0.412	Cauliflowers and broccoli	0.712
Pepper (piper spp.)	0.578	*Fruit, prepared*	0.412	Coconut(copra) oil	0.705
Orange juice, single strength	0.566	Pineapple, canned	0.406	Vegetables frozen	0.697

Source: Authors' calculations based on FAOSTAT 2014. *Note*: Italics denote products with RCA < 1; products with high TEI but which are not being produced in the regions are included as they relate to re-export trade. There were two in the case of COMESA and SADC and six in the case of ECOWAS

16.4 The Outlook for Regional Cross-Border Trade and Market Volatility Under Alternative Scenarios

The preceding analysis presents evidence that African countries could use increased regional trade to enhance the resilience of domestic markets to supply shocks. The high cost of moving goods across domestic and transborder markets and outwardly biased trading infrastructure are major determinants of the level and direction of trade among African countries. A strategy to exploit the regional stabilization potential therefore has to include measures to lower the general cost of trading and remove additional barriers to cross-border trade. This section simulates the impact of such changes on regional trade flows, using IFPRI's regional Economy-wide Multimarket Model (EMM) described below.[4]

16.4.1 The Regional Trade Simulation Model

In this study, the original EMM was modified to differentiate between intra- and extra-regional trade sources and destinations and between informal and formal trade costs in intra-regional trade transactions. In its original version, the EMM solves for optimal levels of supply $QX_{r\,c}$, demand $QD_{r\,c}$ and net trade (either import $QM_{r\,c}$ or export $QE_{r\,c}$) of different commodities c for individual member countries r of the modeled region.

Supply and demand balance at the national level determines domestic output prices $PX_{r\,c}$ as stated by Eq. (16.1), while Eq. (16.2) connects domestic market prices $PD_{r\,c}$ to domestic output prices, taking into account an exogenous domestic marketing margin $marg D_{r\,c}$. The net trade of a commodity in a country is determined through mixed complementarity relationships between producer prices and potential export quantities and between consumer prices and potential import quantities. Accordingly, Eq. (16.3) ensures that a country will not export a commodity ($QE_{r,c} = 0$) as long as the producer price of that commodity is higher than its export parity price, where $pwe_{r\,c}$ is the country's FOB price and $marg W_{r\,c}$ is an exogenous trade margin accounting for the cost of moving the commodity to and from the border. If the domestic market balance constraint in Eq. (16.1) requires that the country exports some excess supply of a commodity ($QE_{r,c} > 0$), then the producer price will be equal to the export parity price of that commodity. Additionally, Eq. (16.4) governs any country's possibility to import a commodity, where $pwm_{r\,c}$ is its CIF price. There will be no import ($QM_{r,c} = 0$) as long as the import parity price of a commodity is higher than its domestic consumer price. The domestic market balance constraint requires that, if a country has to import a commodity to meet a given excess demand ($QM_{r,c} > 0$), then the domestic consumer price will be equal to the import parity price of that commodity.

[4] See Diao et al. (2007) and Nin-Pratt et al. (2011).

$$\mathrm{QX}_{r\,c} + \mathrm{QM}_{r\,c} - \mathrm{QE}_{r\,c} = \mathrm{QD}_{r\,c} \tag{16.1}$$

$$\mathrm{PX}_{r\,c} \cdot (1 + \mathrm{marg}D_{r\,c}) = \mathrm{PD}_{r\,c} \tag{16.2}$$

$$\mathrm{PX}_{r\,c} \geq \mathrm{pwe}_{r\,c} \cdot (1 - \mathrm{marg}W_{r\,c}) \quad \perp \quad \mathrm{QE}_{r,c} \geq 0 \tag{16.3}$$

$$\mathrm{pwm}_{r\,c} \cdot (1 + \mathrm{marg}W_{r\,c}) \geq \mathrm{PD}_{r\,c} \quad \perp \quad \mathrm{QM}_{r,c} \geq 0 \tag{16.4}$$

In the version of the EMM used in this study, the net export of any commodity is modeled as an aggregate of two output varieties differentiated by their market outlets (regional and extra-regional) while assuming an imperfect transformability between the two export varieties. Similarly, the net import of any commodity is modeled as a composite of two varieties differentiated by their origins (regional and extra-regional) while assuming an imperfect substitutability between the two import varieties.

In order to implement export differentiation by destination, the mixed complementarity relationship in Eq. (16.3) is replaced with two new equations which specify the price conditions for export to be possible to both destinations. Equation (16.5) indicates that for export to extra-regional market outlets to take place ($\mathrm{QEZ}_{r\,c} > 0$), suppliers should be willing to accept a price $\mathrm{PEZ}_{r\,c}$ that is not greater than the export parity price when exporting to that destination. Similarly, Eq. (16.6) ensures that exporting to within-region market outlets is possible ($\mathrm{QER}_{r\,c} > 0$) only if suppliers are willing to receive a price $\mathrm{PER}_{r\,c}$ that is not more than the regional market clearing price $\mathrm{PR_c}$ adjusted downward to account for exogenous regional trade margins $\mathrm{marg}R_{r\,c}$ incurred in moving the commodity from the farm gate to regional market (see Eq. (16.17) below for the determination of $\mathrm{PR_c}$).

$$\mathrm{PEZ}_{r\,c} \geq \mathrm{pwe}_{r\,c} \cdot (1 - \mathrm{marg}W_{r\,c}) \quad \perp \quad \mathrm{QEZ}_{r\,c} \geq 0 \tag{16.5}$$

$$\mathrm{PER}_{r\,c} \geq \mathrm{PR_c} \cdot (1 - \mathrm{marg}R_{r\,c}) \quad \perp \quad \mathrm{QER}_{r\,c} \geq 0 \tag{16.6}$$

Subject to these price conditions, Eqs. (16.7)–(16.10) determine the aggregate export quantity and its optimal allocation to alternative destinations. Equation (16.7) indicates that the aggregate export of a commodity by individual countries $\mathrm{QE}_{r\,c}$ is obtained through a constant elasticity of transformation (CET) function of the quantity $\mathrm{QEZ}_{r\,c}$ exported to extra-regional market outlets and the quantity $\mathrm{QER}_{r\,c}$ exported to intra-regional market outlets, where $\rho^e_{r\,c}$, $\delta^e_{r\,c}$, and $\alpha^e_{r\,c}$ are the CET function exponent, share parameter, and shift parameter, respectively. Equation (16.8) is the first-order condition of an aggregate export revenue maximization problem, given the prices that suppliers can receive for the different export destinations and subject to the CET export aggregation function. The equation indicates that an increase in the ratio of intra-regional to extra-regional prices will increase the ratio of intra-regional to extra-regional export quantities (i.e., exports shift toward

destinations which offer higher returns). Equation (16.9) helps identify the optimal quantities supplied to each destination; it states that aggregate export revenue at producer price of export $\mathrm{PE}_{r\,c}$ is the sum of export sales revenues from both intra-regional and extra-regional market outlets at supplier prices, while Eq. (16.10) sets the producer price of export to be the same as the domestic output price $\mathrm{PX}_{r\,c}$, which is determined by the supply and demand balance equation (Eq. 16.1) as earlier explained.

$$\mathrm{QE}_{r\,c} = \alpha^{e}_{r\,c} \cdot \left(\delta^{e}_{r\,c} \cdot \mathrm{QER}^{\rho^{e}_{r\,c}}_{r\,c} + \left(1 - \delta^{e}_{r\,c}\right) \cdot \mathrm{QEZ}^{\rho^{e}_{r\,c}}_{r\,c}\right)^{\frac{1}{\rho^{e}_{r\,c}}} \tag{16.7}$$

$$\frac{\mathrm{QER}_{r\,c}}{\mathrm{QEZ}_{r\,c}} = \left(\frac{\mathrm{PER}_{r\,c}}{\mathrm{PEZ}_{r\,c}} \cdot \frac{1 - \delta^{e}_{r\,c}}{\delta^{e}_{r\,c}}\right)^{\frac{1}{\rho^{e}_{r\,c}-1}} \tag{16.8}$$

$$\mathrm{PE}_{r\,c} \cdot \mathrm{QE}_{r\,c} = \mathrm{PER}_{r\,c} \cdot \mathrm{QER}_{r\,c} + \mathrm{PEZ}_{r\,c} \cdot \mathrm{QEZ}_{r\,c} \tag{16.9}$$

$$\mathrm{PE}_{r\,c} = \mathrm{PX}_{r\,c} \tag{16.10}$$

Import differentiation by origin is implemented by following the same procedure for export differentiation by destination, as described above. Equation (16.4) is replaced by Eqs. (16.11) and (16.12). Accordingly, import from extra-regional origins will happen ($\mathrm{QMZ}_{r,c} > 0$) only if domestic consumers are willing to pay a price $\mathrm{PMZ}_{r\,c}$ that is not smaller than the import parity price for the extra-regional variety. Furthermore, import from intra-regional origins is possible ($\mathrm{QMR}_{r,c} > 0$) only if domestic consumers are willing to pay at a price $\mathrm{PMR}_{r\,c}$ that is not smaller than the regional market clearing price PR_{c} adjusted upward to account for exogenous regional trade margins $\mathrm{marg}R_{r\,c}$ incurred in moving the commodity from the regional market to consumers.

$$\mathrm{pwm}_{r\,c} \cdot (1 + \mathrm{marg}W_{r\,c}) \geq \mathrm{PMZ}_{r\,c} \quad \perp \quad \mathrm{QMZ}_{r,c} \geq 0 \tag{16.11}$$

$$\mathrm{PR}_{r} \cdot (1 + \mathrm{marg}R_{r\,c}) \geq \mathrm{PMR}_{r\,c} \quad \perp \quad \mathrm{QMR}_{r\,c} \geq 0 \tag{16.12}$$

Under these price conditions, Eq. (16.13) represents aggregate import quantity $\mathrm{QM}_{r\,c}$ as a composite of intra- and extra-regional import variety quantities $\mathrm{QMR}_{r\,c}$ and $\mathrm{QMZ}_{r\,c}$, respectively, using a constant elasticity of substitution (CES) function; in the equation, the terms $\rho^{m}_{r\,c}$, $\delta^{m}_{r\,c}$, and $\alpha^{m}_{r\,c}$ stand for the CES function exponent, share parameter, and shift parameter, respectively. The optimal mix of the two varieties is defined by Eq. (16.14), which is the first-order condition of an aggregate import cost minimization problem, subject to the CES aggregation (Eq. 16.13) and given import prices from both origins. An increase in the ratio of extra-regional to intra-regional import prices will increase the ratio of intra-regional to extra-regional import quantities (i.e., imports shift away from more expensive sources). Equation (16.15) identifies the specific quantities imported from each origin. It defines the total import cost at consumer price of import $\mathrm{PM}_{r\,c}$ as the sum of intra-regional and

extra-regional import costs, while Eq. (16.16) sets the consumer price of import to be the same as the domestic market price $PD_{r\,c}$, which is determined by Eqs. (16.1) and (16.2), as earlier explained

$$QM_{r\,c} = \alpha^{m}_{r\,c} \cdot \left(\delta^{m}_{r\,c} \cdot QMR_{r\,c}^{-\rho^{m}_{r\,c}} + \left(1 - \delta^{m}_{r\,c}\right) \cdot QMZ_{r\,c}^{-\rho^{m}_{r\,c}}\right)^{-\frac{1}{\rho^{m}_{r\,c}}} \tag{16.13}$$

$$\frac{QMR_{r\,c}}{QMZ_{r\,c}} = \left(\frac{PMZ_{r\,c}}{PMR_{r\,c}} \cdot \frac{\delta^{m}_{r\,c}}{1 - \delta^{m}_{r\,c}}\right)^{\frac{1}{1+\rho^{m}_{r\,c}}} \tag{16.14}$$

$$PM_{r\,c} \cdot QM_{r\,c} = PMR_{r\,c} \cdot QMR_{r\,c} + PMZ_{r\,c} \cdot QMZ_{r\,c} \tag{16.15}$$

$$PM_{r\,c} = PD_{r\,c} \tag{16.16}$$

After determining export quantities and prices by destination, and import quantities and prices by origin, the regional market clearing price PR_c can now be solved. Equation (16.17) imposes the regional market balance constraint by equating the sum of intra-regional export supplies to the sum of intra-regional import demands, with $qdstk_c$ standing for discrepancies existing in observed aggregate intra-regional export and import quantity data in the model's base year. Thus, PR_c is the price that ensures regional market balance.

$$\sum\nolimits_{r} QER_{r\,c} = \sum\nolimits_{r} QMR_{r\,c} + qdstk_c \tag{16.17}$$

The model is calibrated separately for each of the three RECs. Calibration is performed such that for every member country within each REC, the same production, consumption, and net trade data are replicated as observed for different agricultural subsectors and two nonagricultural subsectors in 2007–2008. Baseline trend scenarios are then constructed such that until 2025, changes in crop yields, cultivated areas, outputs, and GDP reflect the same observed changes. Table 16.6 in the annex compares the calibrated agricultural and economy-wide GDP growth rates under the baseline scenario with the observed rates in the recent years. Although the model is calibrated to the state of national economies 7 years earlier, it closely reproduces the countries' current growth performances.

Four different scenarios are simulated using the EMM. The first is the baseline scenario described above, which assumes a continuation of current trends up to 2025. It is used later as a reference to evaluate the impact of the changes under the remaining three scenarios. The latter scenarios introduce the following three different sets of changes to examine their impacts on regional trade levels: a reduction of 10 % in the overall cost of trading in every country; removal of all cross-border trade barriers–that is, a reduction of their tariff equivalent to zero; and a 10 % yield increase across the board. These changes are modeled to take place between 2008 (the base year) and 2025. The change in cross-border exports is used as an indicator of the impact on intra-regional trade. In the original data, there are large discrepancies between recorded regional exports and import levels, the value of the

latter often being multiples of the former. The more conservative export figures are therefore the preferred indicator of intra-regional trade.

16.4.2 Intra-trade Simulation Results

The results for the different regions are presented in Figs. 16.5 and 16.6. Figure 16.5 presents the results of the baseline scenarios for the three regions from 2008 to 2025. Assuming the current trends to continue, intra-regional trade in both ECOWAS and SADC is expected to expand rapidly but with marked differences between crops. The aggregate volume of intra-regional trade in staples would approach 3 million tons in the case of ECOWAS and about half of that amount in the case of SADC if the growth rates in yields, cultivated areas, and nonagricultural income sustained at their current level until 2025. Cereals would see the smallest gains, while trade in roots and tubers as well as other food crops would experience much faster growth in the case of ECOWAS. This is in line with the current structure of and trends in commodity demand and trade. While the increase in demand for roots and tubers is being met almost exclusively using local sources, the fast growing demand for cereals is heavily tilted toward rice, which is supplied from outside the region. The two leading cereals that are traded regionally, maize and millet, therefore benefit less from the expansion of regional demand and have historically seen slower growth in trade than roots and tubers. In the case of SADC, the rise of Angola as a main exporter of roots and tubers starting in 2013 is a main factor in explaining the strong boost in regional trade of that commodity. Zimbabwe had been the sole exporter of roots and tubers before 2013 and exported only very modest quantities. Hence, the high rates of growth of overall regional exports can be attributed to the developments in Angola.

The story is a bit different in the case of COMESA. As was already made apparent by the market share analysis earlier, the COMESA regional market has been the least dynamic of the three regional markets and the only one associated with a negative market effect. COMESA is the only region where the member countries have experienced a decline in competitiveness as a whole. The underwhelming performance is reflected in the baseline scenario. If current trends were to continue, the levels of intra-regional trade would continue to stagnate, except in the case of cereals. And even for this group of products, the decline in trade volumes would be reversed, but the reversal would not be enough to bring the trade volumes back to their initial levels. The projected evolution of the trade in cereals reflects different country dynamics and a shift in the sources of regional exports. The fall in regional trade levels at the beginning of the period is a result of a continual decline in exports from the two main traditional suppliers Egypt and Malawi. At the same time, the faster growth in several other countries, particularly Tanzania and Ethiopia, results in rising exports from these countries, starting from 2011 for Tanzania and from 2019 for Ethiopia. The result is a U-shaped pattern in COMESA cereals exports: the declining exports in some countries are eventually offset by the increasing imports in other countries. The graphs in Fig. 16.6 show the cumulated changes in intra-

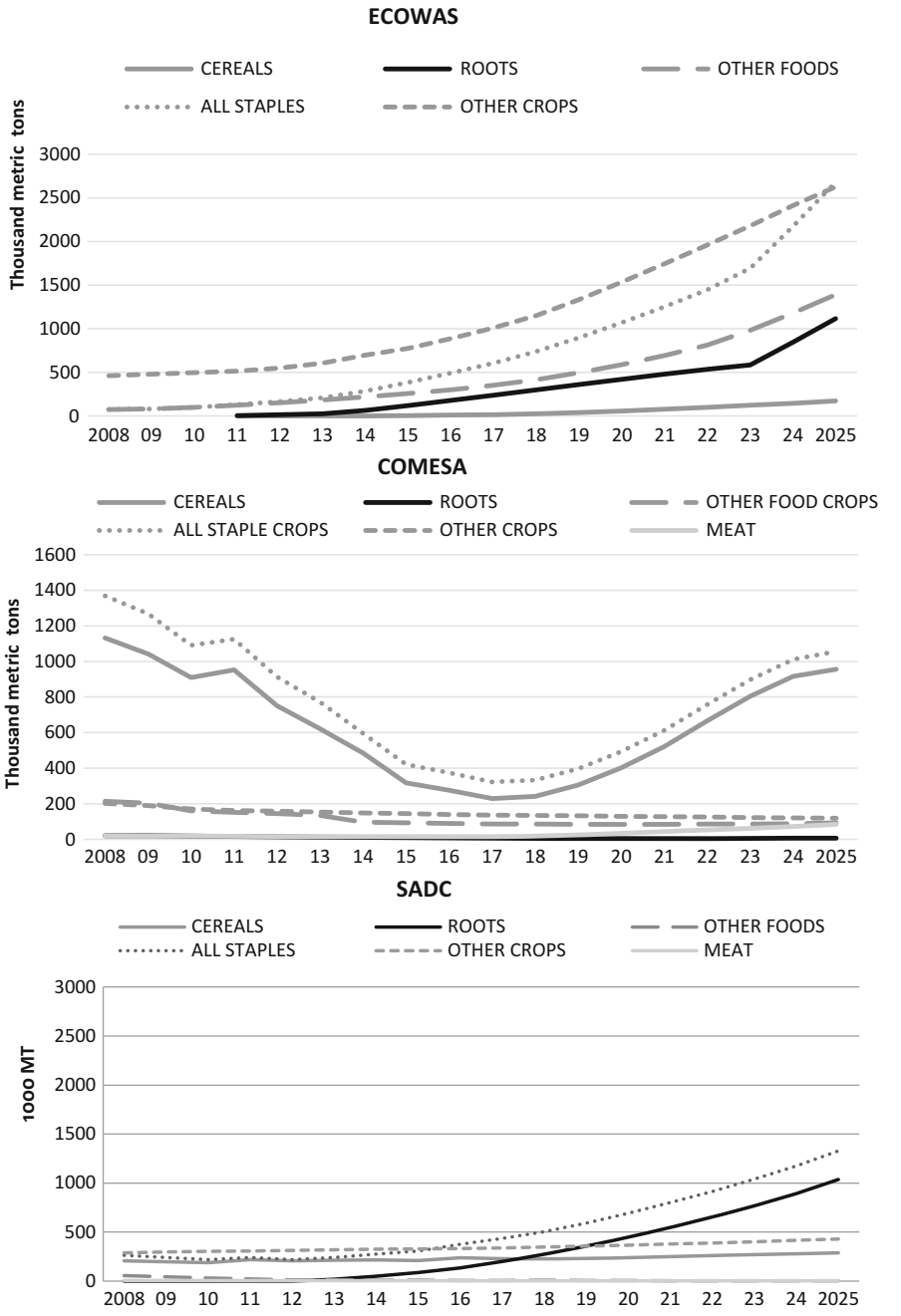

Fig. 16.5 Regional exports outlook, baseline. *Source*: Authors' calculation

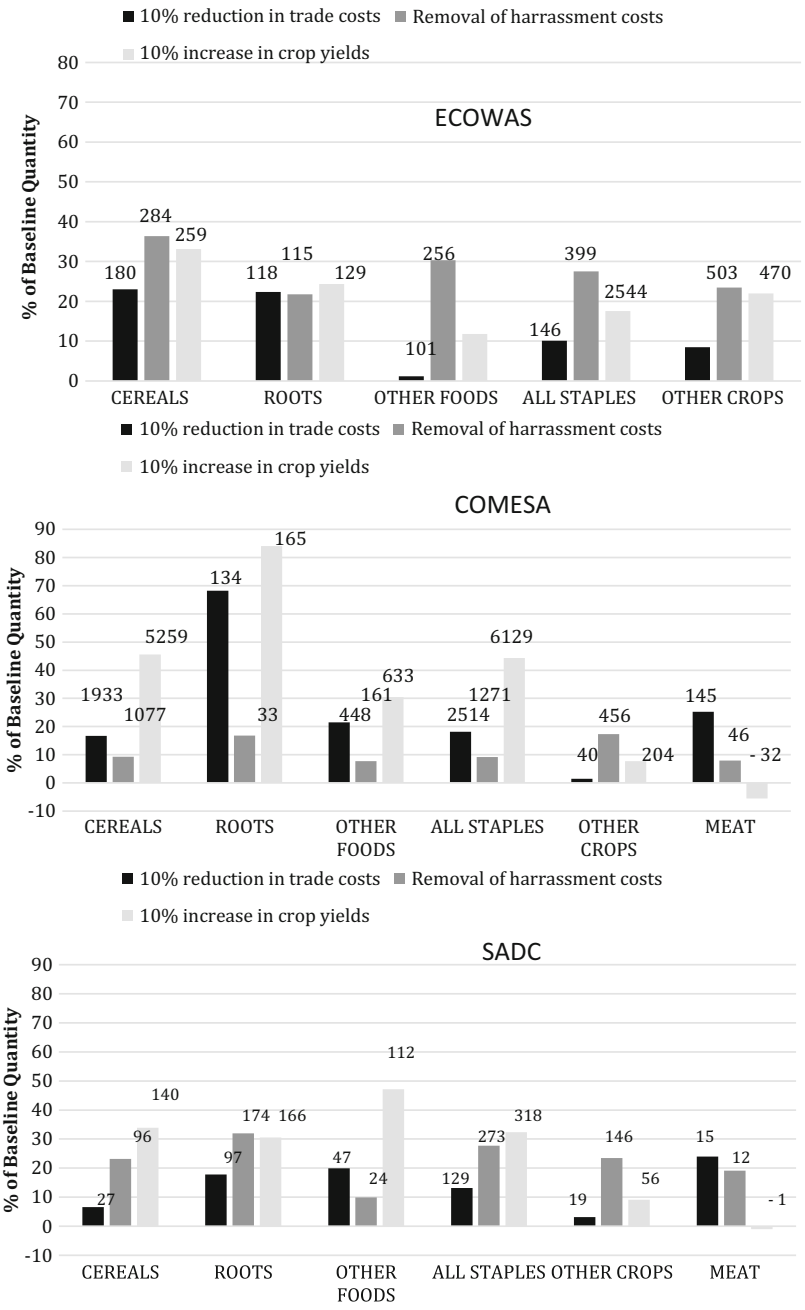

Fig. 16.6 Changes in cost, yields, and exports. *Source*: Authors' calculation. *Note*: Figures above the *bars* indicate cumulative increases in regional export supply in 1000 mt. Other crops include all or subset of the following crops: fruits and vegetables, cotton, sugar, cocoa, coffee, tea, tobacco, spices, and nuts

regional export levels by 2025 compared with the baseline results; the changes are the result of a reduction in total trading cost, removal of transborder trade barriers, and a yield increase. The bars represent the percentage changes, and the numbers above the bars indicate the corresponding absolute changes in 1000 metric tons. The results show that intra-regional trade invariably increases by a considerable margin for cereals and roots and tubers (the main food crops) in response to changes in trading costs and yields. Intra-community trade levels in ECOWAS climb by between 10 and 35 % for most products over the entire period. By 2025, when compared to baseline trends, the volume of cereal trade increases by a cumulative total of between 200,000 and 300,000 mt for individual products and the volume of overall staple trade by between 1.5 and 4.0 million tons. Cereals seem to respond better than other products in general. It also appears that removing transborder trade barriers would have the strongest impact of trade flows across the board.

The COMESA region shows similar increases in overall trade in staples. Cereals trade tends to be proportionally less responsive but because of its initial higher levels, the cumulative additional volume of regional trade is much higher, ranging from 0.7 million to more than 3.0 million tons above the baseline. Also, in contrast to ECOWAS, intra-regional trade in COMESA seems to be more responsive to changes in overall trading costs and yields than to changes in cross-border barriers. This may be explained by the fact that equivalent tariffs constitute a smaller fraction of producer prices, and hence changes in barriers result in smaller changes in incentives. Trade in the SADC region also seems to respond more to changes in transborder trade barriers and yields, as in the case of ECOWAS. A 10 % increase in yields would raise trade in staples by a cumulative volume of slightly more than 3.0 million tons by 2025 compared to the baseline scenario.

16.4.3 Regional Market Volatility Under Alternative Policy Scenarios

Under each scenario, the model-simulated quantities of intra-regional exports QER_{rc} are used to estimate an index of future export volatility at country and regional level as follows: First, a trend-corrected coefficient of variation TCV is calculated for each country, using the following formula as in Cuddy and Della Valle (1978):

$$\mathrm{TCV} = \mathrm{CV} \cdot \sqrt{\left(1 - \overline{R^2}\right)} \tag{16.18}$$

where CV is the coefficient of variation and $\overline{R^2}$ is the adjusted coefficient of determination of the linear trend regression obtained using the time series of aggregate quantities of intraregional exports of all staple food crops from 2008 to 2025.

Second, an index of regional volatility TCV_{REC} is derived for each REC as a weighted average of trend-corrected coefficients of variation of its member countries with the formula

$$TCV_{REC}^2 = \sum_i^n s_i^2 \cdot TCV_i^2 + 2 \sum_i^n \sum_j^n s_i \cdot s_j \cdot v_{ij} \cdot TCV_i \cdot TCV_j \qquad (16.19)$$

where TCV_i and TCV_j are the trend-corrected coefficients of variation in aggregate exports of staple food crops in countries i and j, n is the number of member countries in the REC, s_i and s_j are the shares of countries i and j in the region's overall intra-regional exports of staple food crops, and v_{ij} is the coefficient of correlation between aggregate exports of countries i and j. Finally, the coefficients of variation at country level are normalized by dividing them by the respective regional coefficients.

The historical and simulated levels of cross-border trade volatility of food staples in the various regions are reported in Table 16.4. The volatility levels simulated under historical trends are calculated based on the TradeMaps database.[5] Table 16.5 shows the comparison of the simulated volatility levels under the various alternative scenarios with historical volatility levels, with the difference expressed in absolute point changes. The figures in the two tables show that volatility levels are lower under nearly all scenarios than under historical trends. The only exception is in the case of ECOWAS, where regional cross-border trade volatility decreases with a reduction of overall trading costs, but it rises when cross-border trade barriers

Table 16.4 Regional cross-border trade volatility under various scenarios

	Historical trend (1996–2012)	Baseline trend (2008–2025)	10 % reduction in trade costs (2008–2025)	Removal of cross-border trade barriers (2008–2025)	10 % increase in crop yields (2008–2025)
ECOWAS	0.345	0.33	0.323	0.354	0.378
COMESA	0.682	0.55	0.505	0.551	0.449
SADC	0.73	0.126	0.131	0.173	0.151

Source: Authors calculations from TradeMaps database and EMM model simulation results

[5]In the SADC case, baseline and historical trends of the trade volatility deviate a lot. The main explanation is that, unlike traditional CGE models where countries are exporters or importers from the beginning and remain as such for the length of the simulation period, our model allows countries to enter or exit the regional export market based on relative prices. Therefore, we have used historical production as opposed to trade data to calibrate the model, given that not all countries have historical trade data. The baseline volatility of trade flows is therefore not a result of calibration but rather derives from the calibrated baseline production and its induced trade flows. The SADC region, unlike other regions, has undergone a major structural change in terms of the composition and source of production and thus trade of agricultural products, with Angola, a new player, emerging as the most important trading partner and roots and tubers as the single most important traded agricultural commodity. The projected overwhelming dominance of the more stable Angola in regional production and trade under continuation of current trends is the main explanation of the drop in baseline export volatility.

Table 16.5 Change in regional trade volatility under alternative scenarios (2008–2025)

	Baseline trend	10 % reduction in trade costs	Removal of cross-border trade barriers	10 % increase in crop yields
Absolute point change compared to historical trend				
ECOWAS	−0.015	−0.022	0.009	0.033
COMESA	−0.132	−0.178	−0.132	−0.234
SADC	−0.604	−0.600	−0.557	−0.579

Source: Authors calculations from TradeMaps database and EMM model simulation results

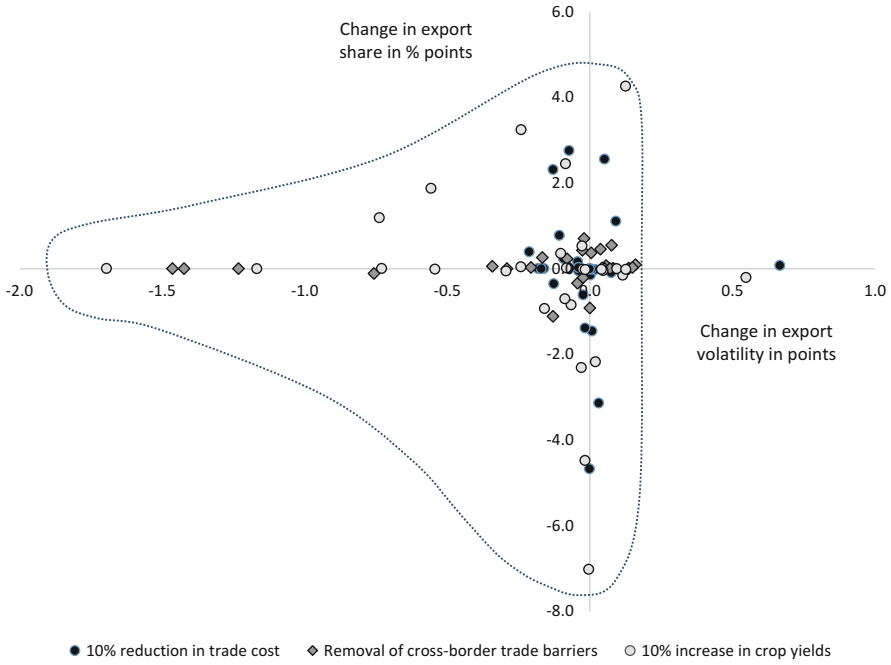

Fig. 16.7 Changes in country export shares and volatility compared to baseline trends

are removed or when yields are increased. The magnitude of changes are, however, rather small across all three scenarios. The figures also show that when the current trend of rising volumes of intra-regional trade continues, volatility levels in all three regions are expected to decline compared to historical trends. A better comparison is therefore to contrast changes that take place under the two trade policy scenarios and the productivity (meaning increasing yields) scenario with the expected volatility levels under the baseline scenario. Furthermore, the direction and magnitude of changes in the level of intra-regional trade volatility are determined by the combined effect of changes in the level of volatility as well as changes in the share of cross-border exports in individual countries. Figure 16.7 above shows changes in volatility

levels (x-axis) and shares of exports (y-axis) by individual countries under each of the scenarios when compared with the baseline. The different dots indicate the position of different countries under the three scenarios. The tilted distribution of country positions to the left of the x-axis indicates that most countries' exports would experience a lower level of volatility.

The combined changes in export share and volatility for individual countries under each of the scenarios are reported in Table 16.7 and presented in Figs. 16.8, 16.9, 16.10 in the Annex. Only countries that have historically exported are considered. Changes in a country's production patterns resulting from the simulated policy actions lead to changes in both the volatility and the level of exports,and hence the shares in regional trade of each country. The magnitude and direction of these changes determine the contribution of individual countries to changes in the volatility level in regional food markets.

16.5 Conclusions

The current chapter has examined the potential to use increased intra-regional trade among Africa's main regional economic communities as a means to raise the resilience of domestic food markets to shocks across their member countries. The distribution and correlation of production volatility as well as the current patterns of specialization in the production and trade of agricultural products among African countries suggest that it is indeed possible to raise cross-border trade to reduce the level of instability of local food markets. The results of the baseline scenario indicate that continuation of recent trends would sustain the expansion of intra-regional trade flows in all three regions, particularly in the ECOWAS region. The findings also reveal that it is possible to significantly boost the pace of regional trade expansion, which in turn would contribute to creating more resilient domestic food markets through modest reduction in the overall cost of trading, a similarly modest increase in crop yields, or the removal of barriers to transborder trade. More importantly, the simulation results also suggest that such policy actions to promote transborder trade would reduce volatility in regional markets and help lower the vulnerability of domestic food markets to shocks.

Appendix

Table 16.6 GDP and agricultural growth rates under baseline and recent trends

	agrGDP		GDP			agrGDP		GDP	
	Baseline	Trends	Baseline	Trends	Baseline	Trends	Baseline	Trends	
Benin	5.23	4.85	4.84	5.13	Burundi	2.50	2.51	6.12	6.70
Burkina Faso	5.36	5.48	5.67	5.50	Comoros	2.75	2.75	3.26	2.60
Cape Verde	2.37	2.03	6.89	7.50	D. R. Congo	1.25	1.25	2.43	2.20
Chad	1.83	1.33	5.61	8.00	Djibouti	2.31	3.24	9.04	3.00
Cote d'Ivoire	2.74	2.21	3.95	3.69	Egypt	3.33	3.39	6.25	5.20
Gambia	4.53	3.96	7.00	7.19	Eritrea	5.26	5.36	5.60	2.90
Ghana	3.56	3.48	6.44	7.06	Ethiopia	6.51	6.52	9.08	8.20
Guinea	5.17	5.00	4.25	4.33	Kenya	2.42	2.17	2.03	3.40
Guinea Bissau	4.02	3.97	3.86	4.30	Libya	1.39	1.43	3.05	2.20
Liberia	2.55	2.00	4.02	5.09	Madagascar	1.99	1.98	3.18	3.90
Mali	3.70	3.26	5.24	6.26	Malawi	1.57	1.57	1.90	2.70
Mauritania	2.54	2.46	4.49	3.22	Mauritius	3.31	3.31	4.58	5.00
Niger	3.25	3.19	2.61	2.84	Rwanda	5.28	5.30	9.39	7.60
Nigeria	5.04	5.00	5.62	4.79	Seychelles	1.48	1.47	−1.89	2.30
Senegal	2.75	2.30	3.52	3.44	Sudan	2.50	2.45	6.40	7.20
Sierra Leone	4.94	4.83	6.08	5.67	Swaziland	1.03	1.11	2.85	2.60
Togo	2.31	1.63	4.54	6.66	Tanzania	4.64	4.65	7.60	6.00
					Uganda	3.01	3.01	6.51	8.10
					Zambia	1.06	0.95	3.49	6.30
					Zimbabwe	−0.51	−0.68	−0.85	1.00

Source: Authors' calculations

Table 16.7 Change in volatility and share of staple exports under alternative scenarios, 2008–2025

	Change in volatility compared to baseline (points)			Change in share compared to baseline (% points)		
	10 % reduction in trade cost	Removal of cross-border trade barriers	10 % increase in crop yields	10 % reduction in trade cost	Removal of cross-border trade barriers	10 % increase in crop yields
Benin	−0.073	−0.043	−0.085	2.756	−0.338	2.448
Burkina Faso	−0.213	0.077	−0.027	0.398	0.545	0.530
Ivory Coast	−0.126	−0.026	−0.066	−0.351	0.428	−0.843
Gambia	−0.039	−0.206	−0.294	−0.047	0.026	−0.052
Ghana	−0.023	−0.079	−0.088	−0.609	0.227	−0.704
Guinea	0.002	0.160	0.116	−0.144	0.095	−0.151
Guinea-Bissau	0.086	0.055	−0.082	0.009	0.005	0.016

(continued)

Table 16.7 (continued)

	Change in volatility compared to baseline (points)			Change in share compared to baseline (% points)		
	10 % reduction in trade cost	Removal of cross-border trade barriers	10 % increase in crop yields	10 % reduction in trade cost	Removal of cross-border trade barriers	10 % increase in crop yields
Liberia	−0.001	0.136	0.094	−0.002	0.003	−0.002
Mali	0.031	0.057	−0.017	−3.137	0.069	−4.475
Niger	0.091	−0.129	−0.241	1.111	−1.115	3.247
Senegal	0.019	0.137	0.126	−0.020	0.014	−0.016
Sierra Leone	0.666	−0.073	−0.242	0.075	0.016	0.045
Togo	0.083	0.150	0.046	−0.038	0.026	−0.042
Egypt	−0.129	−0.020	−0.102	2.315	0.701	0.360
Eritrea	0.075	0.043	0.547	−0.091	0.014	−0.203
Ethiopia	0.052	0.005	0.125	2.557	0.368	4.261
Kenya	0.006	0.081	0.041	−0.009	0.004	−0.016
Libya	−0.001	0.001	−0.004	−4.669	−0.918	−7.018
Sudan	0.007	0.037	0.020	−1.456	0.453	−2.175
Angola	−0.043	−0.024	−0.030	0.165	−0.210	−2.306
Botswana	−0.002	0.052	−0.025	−0.003	0.001	−0.008
Congo, Dem. Rep	−0.182	−1.232	−0.730	0.004	0.000	0.006
Madagascar	−0.162	−1.423	−1.695	0.007	0.001	0.005
Malawi	−0.107	−0.757	−0.557	0.781	−0.114	1.876
Mozambique	−0.130	−1.288	6.099	0.165	0.007	0.194
South Africa	−0.017	−0.166	−0.159	−1.382	0.258	−0.927
Swaziland	−0.002	0.071	−0.016	−0.007	0.001	−0.022
Tanzania	−0.093	−0.342	−0.739	0.237	0.052	1.189
Zambia	−0.170	−1.464	−1.168	0.002	0.001	0.000
Zimbabwe	−0.039	−0.290	−0.543	0.030	0.003	−0.008

Source: Based on simulation results using Economy-wide Multimarket Models of ECOWAS, COMESA, and SADC regions

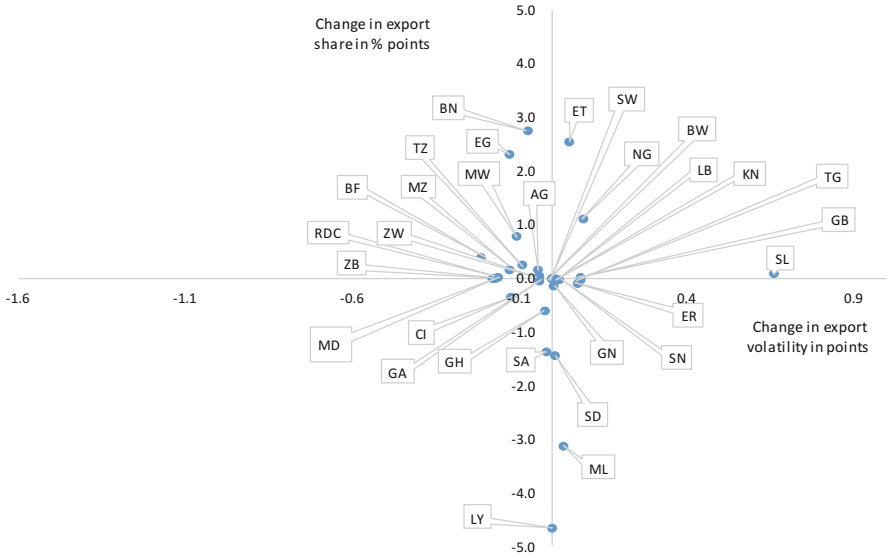

Fig. 16.8 Changes in country export share and volatility under 10 % reduction in trade costs compared to baseline. *Source*: Based on Table 16.7

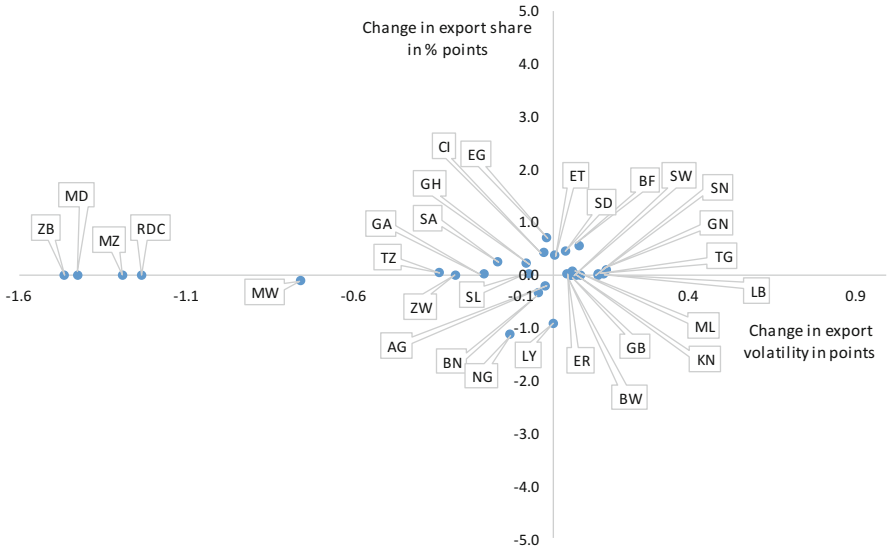

Fig. 16.9 Changes in country export share and volatility under a removal of cross-border trade barriers compared to baseline. *Source*: Based on Table 16.7 above

Fig. 16.10 Changes in country export share and volatility under 10 % increase in crop yields compared to baseline. *Source*: Based on Table 16.7. *Note*: For the sake of clarity, values for Madagascar and Mozambique, which are too large compared to the rest, are not plotted in the figure

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ASEAN Food Reserve and Trade: Review and Prospect

17

Irfan Mujahid and Lukas Kornher

17.1 Introduction

High uncertainty and volatility of food prices in the recent years have renewed the interests of many countries in considering food reserves as an important instrument in managing food price instability. These reserves come back into the focus of policy agenda as a result of the huge doubts on the reliability of international trade to guarantee food supply. The 2008 crisis, in particular, highlighted that low levels of food stocks make countries vulnerable to excessive price volatility even only with low levels of supply or demand shocks (Wright 2009).

Countries in Southeast Asia have been using storage-based price stabilization for decades (Rashid et al. 2007). Grain price stabilization in the Philippines started in 1960s, carried out by Rice and Corn Administration (RCA) and Rice and Corn Board (RICOB). In Indonesia, price stabilization is managed by *Badan Urusan Logistik* (BULOG), a national food reserve agency created in 1967. At the regional level, the cooperation on food reserves has been ongoing since the late 1970s, when the original members of the Association of Southeast Asian Nations (ASEAN) established the Agreement on Food Security Reserve (AFSR). The ASEAN Emergency Rice Reserve (AERR) was created in 1979 with the initial earmarks of 50,000 tons of rice to serve as the subset of national stocks in addressing

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food emergencies in the region. However, due to small size of the stocks and its complex release mechanism, the AERR had never really been activated during the entire operational period of more than a quarter of a century (Dano 2006).

The recent food price crisis affecting almost all countries in the world led to a new phase of the regional reserve cooperation in Southeast Asia. The ten member countries of ASEAN, in partnership with China, Japan, and Korea, agreed on the ASEAN Plus Three Emergency Rice Reserve (APTERR), which entered into force in July 2012. The APTERR is a permanent reserve scheme which replaces the pilot project East Asia Emergency Rice Reserve (EAERR), which itself was presented as a metamorphosis of the AERR. The initial earmark of APTERR is 787,000 tons of rice, roughly twice the size of von Braun and Torero's (2008) proposal for a modest emergency grain reserve of 300,000–500,000 metric tons for the whole world. However, the APTERR has hardly been tested in practice. Since entering into force, only 200 tons of rice have been released at the end of 2012 for poverty alleviation and the malnutrition eradication program in Indonesia, and another 800 tons of rice in early 2014 for typhoon Haiyan victims in the Philippines. Several other small releases have been made during its pilot phase from 2004 to 2010.[1]

This study aims to review the storage-based price-stabilization policy in Southeast Asia, both at the national and regional level, and to discuss the prospect of the policy in the current era of price instability. The remainder of the article is organized as follows: Sect. 17.2 provides information on ASEAN market structure, which will discuss the food trade and development of trade cooperation in the region. Sections 17.3 and 17.4 describe food reserves at the national and regional level in ASEAN, including a discussion on their cost and benefit. The discussion about food reserves at the national level will use several countries in ASEAN as examples, while at the regional level, the discussion will mainly focus on the ASEAN+3.[2] Section 17.5 analyzes the WTO rules on public stockholding, and the last section provides the concluding remarks.

17.2 ASEAN Food Market Structure

The recent waves of global food price crisis have affected almost all countries in the world. ASEAN countries are among those that are hit by the price crisis. Since 2007, the food price index increases have been higher than the consumer price index increases in the region (Fig. 17.1).

ASEAN countries accounted for 29 % of the total global rice output in 2013, while maize production in this region accounted only for 4 % of the total global output. Countries in this region are not traditional producers of wheat and other

[1] www.apterr.org, accessed on 17 September 2014.

[2] Association of Southeast Asian Nations (ASEAN) members are: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam; Plus Three Countries (+3) are China, Japan, Rep. Korea.

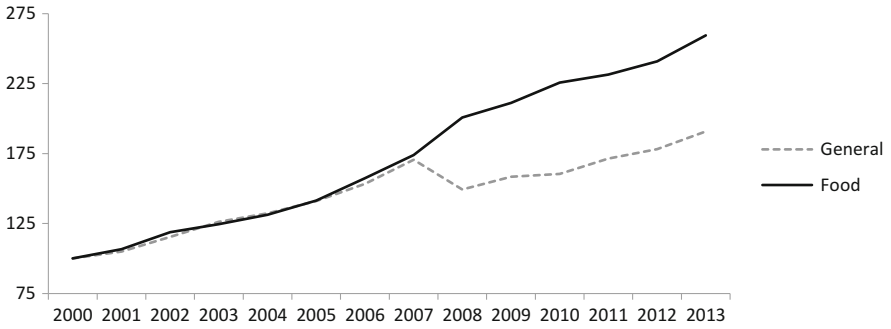

Fig. 17.1 General and food price index in Southeast Asia (2000 = 100). *Source*: FAOSTAT

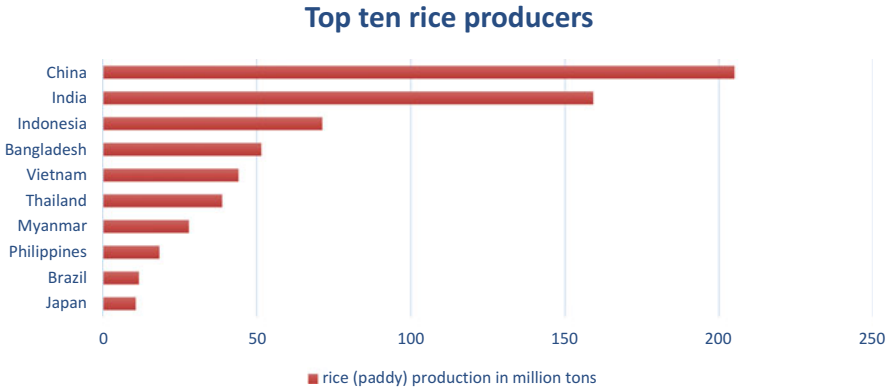

Fig. 17.2 World's rice production in 2013. *Source*: FAOSTAT

cereals. The countries rely heavily on import for their supply of these commodities. Most Southeast Asians eat rice as their main staple food. Rice constitutes more than half of the population's total calorie intake from cereal. In Thailand and Vietnam, rice accounts even for more than two-third of their total calorie intake from cereal.[3]

ASEAN provides a mix of cases. It is home to some of the world's biggest producers, consumers, exporters, and importers of rice at the same time. Thailand and Vietnam are among the biggest rice exporters, whereas Indonesia, Malaysia, and the Philippines are among the biggest rice importers in the world. However, Indonesia and the Philippines, with their goals to achieve self-sufficiency, view trade as the last source of supply, making them occasional rice importers depending on their production level. Other countries such as Singapore and Brunei are considered as traditional purchasers of rice (Fig. 17.2).

[3]Own calculation based on FAOSTAT data. The shares are among cereals, in 2012.

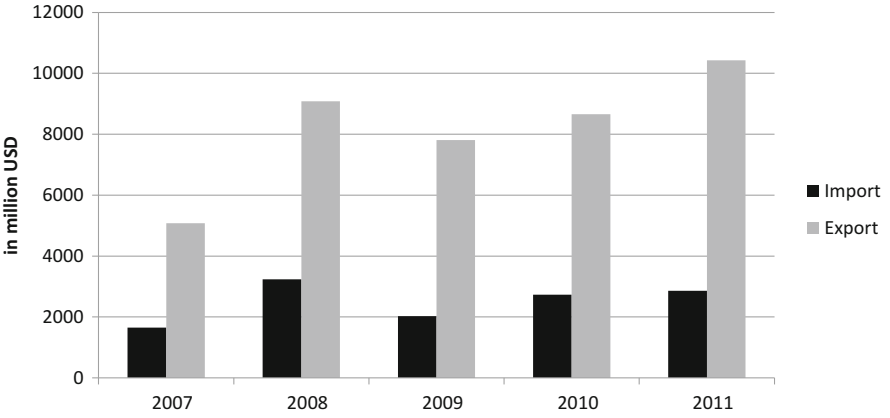

Fig. 17.3 ASEAN rice trade 2007–2011. *Source*: FAOSTAT

Table 17.1 ASEAN rice trade balance 2011 (million USD)

Country	Import	Export	Net import
Brunei	39.6	2.0	37.6
Myanmar	1.6	98.5	−96.9
Indonesia	1513.2	0.8	1512.3
Cambodia	4.9	107.9	−103.1
Lao PDR	9.8	NA	NA
Malaysia	606.1	0.4	605.7
Philippines	383.2	1.7	381.5
Singapore	284.3	52.6	231.6
Thailand	8.9	6507.5	−6498.6
Vietnam	1.3	3656.8	−3655.5

Source: FAOSTAT

The international rice market has been historically thin and unstable (Dawe and Timmer 2012). The geographic concentration of rice production and the thinness of international rice trade with high transactions costs are among the factors contributing to its instability. Only about 5 % of the total global rice production enters the international market, which is mostly concentrated in Asia. Southeast Asia as a region is a net rice exporter (Fig. 17.3), but the bulk of the countries are rice importers (Table 17.1).

ASEAN countries' imports are mainly sourced from within the region. The countries in this region absorb roughly one-third of the total regional exports and send the excess rice supply to the rest of the world (Fig. 17.4).

The average rice tariff rates of ASEAN countries are relatively high compared with other commodities. In 2012, the tariff for rice was 15.94 % on average among ASEAN countries, which was much higher than the total average tariff rates for all commodities (Table 17.2).

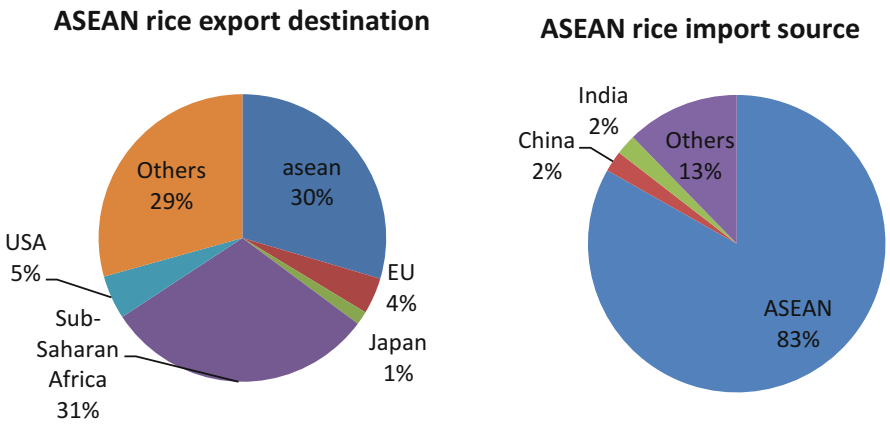

Fig. 17.4 ASEAN rice trade flow 2011. *Source*: UN COMTRADE

Table 17.2 Average tariff rates of ASEAN countries' in 2012 (%)

Sector	Tariff rates
All commodities	5.42
Food commodities	7.01
Rice	15.94

Source: TRAINS database accessed via WITS
Note: Average tariff rates not weighted, classification based on standard product in SITC

Southeast Asian countries liberalize their markets through regional and multilateral trade agreements. The cooperation through ASEAN started in 1967, and all ASEAN members are currently also members of the World Trade Organization (WTO). Through the ASEAN Trade in Goods Agreement (ATIGA), which supersedes the Common Effective Preferential Tariff (CEPT) scheme implemented in 1992, international trade within the region is almost without tariffs except for certain sensitive commodities. In addition to bilateral cooperation between ASEAN members and many other countries, the members also build cooperation with neighboring countries while maintaining ASEAN centrality (Fig. 17.5). There are AK-FTA (with Rep. Korea), AC-FTA (with China), AANZFTA (with Australia and New Zealand), and AI-FTA (with India). Although the agreement of ASEAN and Japan has not yet entered into force, many ASEAN members have already established bilateral agreement with Japan. Furthermore, Regional Comprehensive Economic Partnership (RCEP), which will combine ASEAN and their six partners, is currently under negotiation.[4] ASEAN itself is entering a new phase of stronger cooperation through the ASEAN Economic Community (AEC) in 2015.

[4]RCEP participating countries are ASEAN countries (Brunei, Burma, Cambodia, Indonesia, Laos, Malaysia, Singapore, Thailand, Philippines, Vietnam) plus their six partners (Australia, China, India, Japan, New Zealand, and South Korea), launched in November 2012.

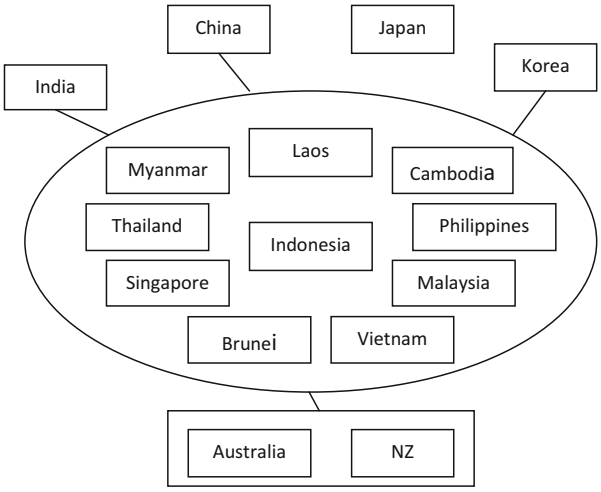

Fig. 17.5 ASEAN free trade agreement. *Source*: WTO

Table 17.3 Tariff of selected agricultural product of different trade agreement regimes 2012 (%)

Commodity	MFN applied	ATIGA	AKFTA	ACFTA	AANZFTA	AIFTA
Animals & product	4.6	0.0	0.1	0.0	0.8	2.2
Dairy products	5.4	0.0	0.0	0.0	0.8	2.2
Fruit, vegetables, & plants	5.3	0.0	0.1	0.0	1.2	3.8
Coffee & tea	6.4	0.0	0.0	0.0	0.4	4.3
Cereals	11.8	7.1	7.3	7.3	7.7	10.1
Oil seeds, fats, & oils	4.3	0.0	0.0	0.0	0.1	2.3
Sugar	12.8	8.1	8.1	8.1	8.1	10.4
Cotton	4.0	0.0	0.0	0.0	0.0	1.6
Other agriculture products	4.1	0.0	0.0	0.0	0.1	2.4

Source: WTO. *Note*: *MFN* most favoured nations, *ATIGA* ASEAN Trade in Goods Agreement, *AK FTA* ASEAN Korea FTA, *AC FTA* ASEAN China FTA, *AANZFTA* ASEAN Australia New Zealand FTA, *AI FTA* ASEAN India FTA

However, despite having significantly reduced their tariffs on many commodities through trade agreements among ASEAN members (and plus countries), considerably high cereals tariffs are still in place (Table 17.3). Cereal products, especially rice, are considered highly sensitive commodities in ASEAN, and thus ASEAN countries still make exceptions by not reducing the tariff on these commodities.

17.3 National Food Reserves in Southeast Asia

The fact that the international rice market has been historically thin and unstable forced countries in this region to prevent the transmission of world price fluctuations to domestic markets (Dawe and Timmer 2012; Rashid et al. 2007). Storage-based public intervention policies have been part of their development agenda for many years to control food availability in the market.

Food price stabilization in the Philippines is managed by the National Food Authority (NFA), which acts as a regulator as well as a corporation engaged in grain trading. The history of the NFA started in the 1960s, when the RICOB and the RCA were still active. In 1972, the National Grains Authority (NGA) replaced these two agencies to promote the integrated growth and development of the grain industry in the country. In 1981, the NGA was transformed to the NFA, and the new organization has two primary mandates: ensuring food security and stabilizing the supply and price of rice. This highlighted the importance of rice in the society. The NFA aimed to fulfill its mandates through procurement, distribution, importation, and buffer stock activities. For the buffer stock activities, the NFA is required to maintain rice stocks which are equivalent to 15 days of consumption for the entire country in its warehouses (Aquino et al. 2013).

In Indonesia, price stabilization was managed by BULOG, a national food reserve agency created in 1967 with the special objective to protect Indonesian domestic markets from sharp price fluctuations on world markets. BULOG buys excess rice production that is not absorbed by the market during harvest seasons from farmers, keeps the rice in its warehouses throughout the country, and distributes the rice at low prices during planting seasons, drought, or other conditions that may cause sharp increases in market rice prices. BULOG maintains a ceiling price policy to ensure the affordability of rice for low-income consumers, especially those living in urban areas. Like the NFA in the Philippines, BULOG also monopolizes rice imports in Indonesia.

As rice importers, Indonesia and the Philippines mainly control rice imports. Other countries, such as Vietnam, which is an exporter country, also use public reserve policies to control rice exports. VINAFOOD in Vietnam is responsible for managing rice availability and rice prices in the market.

17.3.1 Benefits and Costs of National Reserves

Although it is difficult to separate the contributions of policies, we have provided some reviews and discussions on the costs and benefits of national food reserve using qualitative approaches. Rashid et al. (2007) argued that storage-based price-stabilization policies benefit countries through price stability and better agricultural performance. Southeast Asian countries were among those that successfully

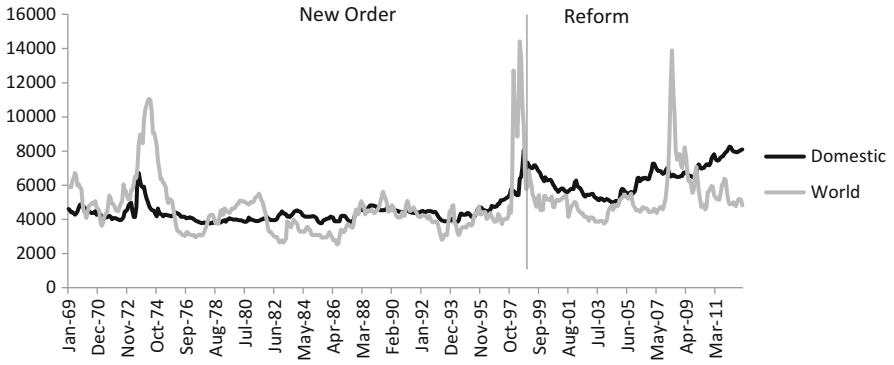

Fig. 17.6 Rice prices in Indonesia during "New Order" and "Reform." *Source*: Dawe (2008) and GIEWS

managed their domestic food prices for years. Under the "New Order,"[5] Indonesia was one of the success stories of food price stabilization, especially for rice. From 1969 to 1997, domestic rice prices were substantially less volatile than in the "reform"[6] period after 1998, when BULOG has less power to intervene in the market[7] (see Fig. 17.6). In Vietnam, agricultural policies introduced in the early phase of the unification of North and South Vietnam have transformed the country with disappointing agricultural production to one of the biggest rice exporters in the world.

Price stability benefits consumers and producers at the same time (Timmer 1989). Poor consumers in Southeast Asia, like many others in developing countries, spend more than half of their income on food (von Braun and Tadesse 2012). Excessive price volatility and spikes can cause food and nutrition insecurity for those consumers who cannot maintain consumption stability. Reducing food and nutrition intake, even only temporarily, can have short- and long-term effects (Block et al. 2004). Price-stabilization policy serves as a preventive program instead of a response program for emergency cases. This kind of policy can help consumers better manage their expectations on food prices and thus better manage their food and nutritional intake. Price stability also helps producers maintain consumption stability because most farmers in Southeast Asia are also categorized as poor citizen living in rural areas.

Furthermore, price stability allows farmers to better manage price expectations on food crops, which can enhance efficiency in the farming sector through better management of planting systems. Moreover, price stability contributes to social and

[5]"New Order" refers to the government lead by President Soeharto, in power from 1967 to 1998.

[6]"Reform" refers to democratization era in Indonesia after the lost power of Soeharto regime in 1998.

[7]Empirical test using standard deviations of log of prices in difference (SSD) shows 0.05 for the periods before 1998 and 0.1 for the periods after 1998.

political stability. Arezki and Brückner (2014) showed that price movements can induce political instability, which is manifested in political riots and civil conflicts. Sociopolitical instability can in turn make it difficult for governments to promote growth and development.

Food price stability is in fact associated with the rapid economic growth during the early development phase in Southeast Asia (Dawe and Timmer 2012; Cummings et al. 2006). However, the downside of stabilization policies are that the fiscal costs of public reserves are often high, while the benefits may not be as high as expected. In the Philippines, for instance, the government spending on the NFA surpassed its spending on agrarian reform, research and development, and extension services during the period of 2003–2008 (Aquino et al. 2013). In Indonesia, a financial audit report by Arthur Anderson covering the period from April 1993 to March 1998 suggested that total inefficiency of BULOG was about US$400 million per year (Arifin 2008). Likewise, the economic costs of distorting market and crowding out private storage and trade can also be very high.

Over decades, there have been several shifts in the price-stabilization policies in Southeast Asia. In the 1980s and 1990s, public reserves fell out of favor particularly because of the changing interest of many countries, which wanted to improve market efficiency. Fiscal difficulties caused by the Asian crisis in the late 1990s triggered countries in the region to intervene less in the market. Indonesia loosened its monopolistic structure and created competition within the domestic market. BULOG lost its domestic power to monopolize the sugar and rice trade because Indonesia was required to comply with the International Monetary Foundation (IMF) Letter of Intent by liberalizing its market.

17.4 Regional Food Reserve Cooperation

Following the global food price crisis in 2008, ASEAN countries agreed on the ASEAN Integrated Food Security (AIFS) framework, which aimed to address four major components of the food security challenges: food security arrangements and emergency short-term relief, sustainable food trade development, integrated food security information system, and agricultural innovation. The AIFS framework provides the foundation for the establishment of the APTERR, an ASEAN regional reserve cooperation together with its three partners.[8] The APTERR was finally agreed upon in October 2011 and entered into force in July 2012.

The history of the APTERR dates back to 1979, when the original members of ASEAN[9] agreed on the ASEAN Emergency Rice Reserve (AERR). The objective was to build up physical rice reserves that would serve the needs of member countries when the demand in any member country cannot be fulfilled from own

[8]China, Japan, and Rep. Korea.

[9]Five original members are: Indonesia, Malaysia, Philippines, Singapore, and Thailand; current ASEAN members also include Brunei, Cambodia, Laos, and Vietnam.

production or through purchases in international market. The main reason for the cooperation was that the ASEAN countries identified food instability as a common threat and as the consequence of the high vulnerability of the region's food production. The AERR was created with the initial earmarks of 50,000 tons of rice as a subset of national stocks. Releases from the AERR were to be arranged through bilateral negotiation between a country in a state of emergency and a country offering its earmarked reserve. The system, however, was never used, and the amount of rice in the reserve was too undersized to cope with an actual emergency.

The efforts of building up stocks in the region continued. In 2001, ASEAN countries, in partnership with China, Japan, and Korea, initiated a consultation and cooperation process in establishing an emergency rice reserve at the regional level. A pilot project of the East Asia Emergency Rice Reserve (EAERR) was created at the end of 2003 with the political support of the ASEAN Plus Three countries. The purpose of the EAERR is twofold: maintaining food security in case of emergency and contributing toward price stability in the region (APTERR 2014). The food price crisis in 2008 led the ASEAN Plus Three governments to strengthen the financial and stockpiling abilities of the EAERR and move beyond the project beyond its pilot phase. The APTERR was finally agreed upon as a permanent scheme in October 2011 and entered into force in July 2012.

The initial earmarked stock of the APTERR is 787,000 tons of rice, which were voluntarily contributed by the member countries (Table 17.4). The stocks remain owned and controlled by the respective governments for meeting the needs of any other member countries in case of emergency. The governments are also responsible for the management cost of their earmarked stocks to ensure the stocks remain in

Table 17.4 Earmarked stock of APTERR

Country	Earmarked stocks (tons)
ASEAN countries	
Brunei Darussalam	3000
Cambodia	3000
Indonesia	12,000
Lao PDR	3000
Malaysia	6000
Myanmar	14,000
Philippines	12,000
Singapore	5000
Thailand	15,000
Vietnam	14,000
Plus Three countries	
China	300,000
Japan	250,000
Korea	150,000
Total	787,000

Source: APTERR

good quality. Another type of APTERR stock is a stockpiled emergency rice reserve, which could be in form of cash or rice, but is owned collectively by APTERR member countries and managed by the APTERR secretariat under the supervision of the APTERR council.[10]

The APTERR is designed to mainly address emergency situations anywhere in the region. Emergency is defined as "the state or condition having suffered extreme and unexpected natural or man-induced calamity, which is unable to cope with such state or condition through its national reserve and is unable to procure the need through normal trade."[11] In principle, given the definition of emergency, extreme price volatility is not a reason for releasing rice from the APTERR.

The APTERR presents itself as a subset of national reserves. Rice release from the APTERR is only possible when a national reserve is unable to cope with extreme shocks. The release of APTERR stock is based on the request of the member country which encounters an emergency rice shortage. The requesting country is also responsible for the transportation and operational costs incurred during the stock release.

The APTERR heavily relies on the commitment and political will of every member country, without any sanction mechanism in place. Nevertheless, APTERR member countries appoint a Management Team to ensure rice releases take place in case of emergency.

17.4.1 The Benefits and Costs of Regional Reserves

There have been extensive debates on storage-based price-stabilization policies (Galtier 2013). On the one hand, countries with public reserve policies can benefit from price stability and better agriculture performances, which are associated with economic success. On the other hand, the policies are often criticized for their high fiscal and economic costs.

National public food reserves in Southeast Asia are largely managed as buffer stocks to address price instability. The size of national public food reserves is usually large, and their stocks are frequently rotated to maintain the quality of the stocks. Consequently, the fiscal costs of storing food/grains are high, and the potential of creating market distortion is high as a result of the high degree of intervention. On the other hand, an emergency public reserve usually holds a low amount of stocks and is only intended for addressing humanitarian needs rather than for price stabilization.

In the competitive storage model, the central idea behind storing food today for tomorrow's consumption is based on the assumption that an equilibrium price can be reached when today's price (p_t) equals the expected price tomorrow (p_{t+1}) plus the costs of storage. Stocks are held in anticipation of profit, which implies that the

[10]The APTERR council is composed of one representative from each APTERR member country.

[11]ASEAN Integrated Food Security Framework.

marginal gain of holding stocks should exceed the marginal cost. However, under this condition, the optimal stock level is not necessarily optimal from the social welfare perspective.

Using this assumption, public involvement in stockholding is needed to address the economy-wide consequences of demand or supply shocks. Difficulties arise when determining the optimal stock level (Gardner 1979) as it depends on the criterion of desirability. For instance, public rice stocks maintained by the NFA in the Philippines are equivalent to 15-day consumption needs of the entire country (Aquino et al. 2013). This stock level is determined based on the assumption that the national stock level (public and private) should be equivalent to the 90-day consumption needs, which covers the lean season, when usually no harvests from domestic production prevail.

Notwithstanding the difficulties in determining the optimal stock level, we provided an illustration on how regional cooperation can significantly reduce the required stocks.[12] Following Kornher and Kalkuhl (2014), we estimated the required stocks as the difference between the largest historic supply shortfall and the percentage of threshold:

$$S = \max\left[\left(1 - \frac{x}{100}\right) E\left(Q_t\right) - Q_t\right] \tag{17.1}$$

where x is the level of allowed supply shortfall. For instance, if we want to maintain 97 % consumption stability, then the allowed supply shortfall is 3 %. $E(Q_t)$ is the expected supply level at time t. Since supply for consumption increases with population growth, we measured shortfall around a trend.

Supply shortfalls of countries individually were compared with the total supply shortfalls of the entire region using the coefficient of variation of supply, which can be written as:

$$\mathrm{CV}^2\left(\sum_1^n Q_i\right) = \sum_1^n s_i^2\ \mathrm{CV}\ \left(Q_i\right) + 2\sum_1^n \sum_{i+1}^n s_i s_i + 1\ r_{i,\,i+1}\ \mathrm{CV}\left(Q_i\right)\mathrm{CV}\left(Q_{i+1}\right) \tag{17.2}$$

where $\mathrm{CV}^2\left(\sum_1^n Q_i\right)$ is the coefficient of variation of the regional supply, and Q_i is the supply of each country. s_i and $r_{i,\,i+1}$ are a country's share and coefficient of correlation, respectively. This condition assumes that there is free flow of food between the countries within the region. Production shortfall can be compensated by imports, which means that the supply shortfall in one country can be compensated by supply surpluses in other countries.

[12]Further discussion on optimal stock level can be found in Kornher and Kalkuhl (2014).

Table 17.5 Stocks required for allowed supply shortfall of 3 % (tons)

	w/o cooperation		With cooperation		Actual APTERR stock	
	Required stock	Stock-to-use ratio	Required stock	Stock-to-use ratio	Earmarked stock	Stock-to-use ratio
ASEAN						
Brunei	1227	23.22	688	13.02	3000	56.76
Cambodia	47,768	12.95	26,799	7.27	3000	0.81
Indonesia	57,413	1.05	32,210	0.59	12,000	0.22
Lao PDR	18,912	10.73	10,610	6.02	3000	1.7
Malaysia	17,947	5.59	10,069	3.14	6000	1.87
Myanmar	34,552	2.37	19,385	1.33	14,000	0.96
Philippines	78,355	5.41	43,960	3.04	12,000	0.83
Singapore	10,420	23.28	5846	13.06	5000	11.17
Thailand	130,132	8.60	73,008	4.82	15,000	0.99
Vietnam	136,657	5.42	76,669	3.04	14,000	0.55
Plus Three						
China	678,268	3.2	380,533	1.8	300,000	1.42
Japan	132,280	8.7	74,214	4.88	250,000	16.45
Korea	59,788	6.93	33,543	3.90	150,000	17.40
Total	1,403,717	3.81	787,535	2.14	787,000	2.14

Source: Own elaboration based on USDA PSD. *Note*: required stocks w/o cooperation and with cooperation are calculated for 2 months consumption

Considering that not all of ASEAN countries are rice producers, supply data (production + imports) was used instead of production data only. Rice supply in Singapore, for instance, relies heavily on imports. Using the actual rice supply data of ASEAN+3 countries from the USDA PSD for the period of 1980–2014, we estimated the required stocks for the 2-month consumption stability at 97 % (allowed supply shortfall of 3 %). Countries' stocks were determined from the regional stocks using their consumption shares. The results of the estimations are presented in Table 17.5.[13]

The simulations showed that regional cooperation can significantly reduce the required rice stock by roughly 44 %, from 1,403,717 to 787,535 tons. This implies that the fiscal costs associated with holding stocks can be reduced through cooperation and risks sharing. The simulations also showed that all countries can reduce the required contributions of stocks through regional risk sharing.

In the APTERR system, stocks remain owned and controlled by the respective governments for the purpose of meeting the needs of any other APTERR member countries when they experience an emergency. However, transportation costs arise when transferring rice from a donor country to a country in need. This transportation costs should also be taken into consideration when calculating the cost reduction

[13]Correlation matrix of supply shortfall, maximum shortfall, average annual supply, and consumption shares that were used for the estimations are available in Appendix.

Table 17.6 Storage and transportation cost (million USD)

	Storage cost		Transportation cost		Total cost	
	Low	High	Low	High	Low	High
w/o cooperation	35	49	–	–	35	49
With cooperation	20	28	0.7	1.1	20.7	29.1
Cost savings					14.3	19.9

Source: own elaboration. *Note*: Storage cost is estimated in the range of US$25 (low) to US$35 (high) per ton. Transportation cost within ASEAN+3 countries is estimated in the range of US$10 (low) to 15 (high) per ton

resulting from cooperation. Since transportation costs arise only when a country within the region experiences a shortfall, we calculated the transportation costs from the expected trade volume[14] in times of shortfall, which was estimated to be equal to the required stocks for 2 months consumption. The results are available in Table 17.6.[15]

The total cost saving through food reserve cooperation was estimated to be about US$14.3–19.9 million when storing enough food to satisfy consumption for 2 months. The saving is roughly 40 % of the estimated cost without cooperation.

The current APTERR stock is roughly equal to the total stocks needed by the region to maintain consumption stability at 97 % for 2 months. However, the voluntary contribution of each member country of the APTERR is not the same as the required stock for each country with cooperation through risks sharing. For instance, Japan and Korea contribute more than what they need, but Cambodia and Lao PDR contribute less than their required stocks. Richer countries of the APTERR are more likely to provide food assistance to their poorer neighboring countries. This can be seen also from the voluntary contributions of APTERR member countries: each of the "Plus Three" countries contributes more than the total contribution from all ASEAN countries. There is a strong indication that the large contribution from the "Plus Three" countries has brought APTERR into practice. Its predecessor, the AERR, which consisted only of ASEAN members with small size of stock, had never released its stock during its entire operational period.

We also conducted a simulation to determine the required stock for ensuring consumption stability of 97 % in different cooperation regimes in order to analyze whether countries benefit from larger cooperation (Table 17.7). Through our simulation of three scenarios—ASEAN, ASEAN+3, and ASEAN+3 plus India—we found that the benefits of cooperation decreased when more countries joined the cooperation. This is possible because the correlation of shortfall risks increases with the increasing number of member countries. However, although the benefits of cooperation were decreasing, the required stock was still significantly reduced.

[14]The expected trade volume in times of shortfall is based on the mean value of the historical regional shortfalls.

[15]Numbers of supply shortfall for each country are available in Appendix.

Table 17.7 Stocks required for allowed supply shortfall of 3 % in different (tons)

Regional cooperation (simulation)	Required stocks without cooperation	Required stocks with cooperation	Reduced by (%)
ASEAN	533,382	178,885	66
ASEAN+3	1,403,717	787,535	44
ASEAN+3+India	2,362,418	1,637,777	31

Source: Own elaboration based on USDA PSD

For instance, if India also joined the ASEAN+3 cooperation, the required stock would be reduced by 31 %. Moreover, larger cooperation means larger coordination between countries, which can potentially prevent collective action failures.

17.5 WTO Rules on Public Reserve

The central issue in a WTO-compatible framework for developing countries, including those in Southeast Asia, is whether these countries are able to stockpile their staple food (i.e., rice) to ensure stable incomes for their farmers while ensuring that their low-income citizens are able to access the basic food at an affordable price. This issue, however, affects or has the potential to affect other countries. The potential spillovers of public reserves are high in different member countries due to different conditions of countries in ensuring food security for the citizens. The increasing demand for food for stockholding purposes increases prices and potentially reduces supply for immediate consumption in other countries. When food stocks are finally released for consumption, international trade can be distorted, affecting market competition.

The present WTO rules allow member countries to maintain or introduce domestic support measures without any limitations or reduction commitments. To qualify for this, domestic support to food reserves must meet "the fundamental requirement that they have no, or at most minimal, trade distorting effect or effects on production."[16] Countries, however, may argue the definition of minimal trade distorting effects.

A public reserve is not only economically complex but also politically encumbered. The Bali Package, which has been mentioned as the first-ever agreement reached in the history of the WTO, still makes an exception for public stockholding. In the 9th ministerial meeting held in Bali, Indonesia, at the end of 2013, the WTO member countries adopted an interim solution and agreed to negotiate a permanent solution that would specifically address public reserve by the 11th

[16]WTO Agreement on Agriculture.

ministerial conference in 2017. Furthermore, in the Post-Bali work, countries also agreed to continue with the interim solution if the permanent solution cannot be agreed upon by 2017. This means that no agreement has been reached for a public reserve. Nevertheless, the interim solution, which should prevent countries from challenging other countries through dispute settlement mechanism until a permanent solution is found, can be a starting point for a new institutional arrangement to prevent collective action failures of uncoordinated national public reserves, which can further destabilize prices at the international level.

17.6 Conclusion and Policy Implication

Public food reserve policies have been used by many countries for decades. Although in the 1980s and 1990s, public reserves fell out of favor with many countries particularly against the backdrop of changing interest, with the countries turning their attention to improving market efficiency, the policy has always been part of the development agenda of many countries. Storage-based stabilization policy through public food reserve is receiving much more attention today in the era of increasing food price volatility. Food security concerns in the recent years have led many countries to reconsider using public food reserve as the main policy to deal with such uncertainty and price instability.

ASEAN countries have provided an interesting case with their long experience in implementing storage-price-based stabilization policies. Despite the difficulties in measuring the impact of different policies, price stabilization has been an integral part of the development agenda of ASEAN countries for decades and has contributed to price stability, which is associated with the economic successes in this region. ASEAN also has shown that cooperation at the regional level is possible. The APTERR presents itself as a regional effort to face the common challenges of ensuring food security.

One of the main concerns regarding public reserve is that the fiscal cost of storing food is relatively high. The cost, however, can be reduced with cooperation. The simulations have shown that regional cooperation significantly reduces the required stocks, which in turn reduces the costs of holding them. Even when transportation cost arising because of decentralized storage in the different countries is taken into account, the total cost for food reserve with cooperation is still lower than without cooperation. This definitely will be beneficial for all participating countries. Admittedly, determining the optimal stock level is difficult. It always depends on the criterion of desirability. The current earmarked stock of the APTERR is designed mainly to address emergency situation rather than for price stability. However, it may have a calming effect on the market and thereby prevent the rapid increase in food prices.

ASEAN and their partner countries can also consider expanding their cooperation to include other neighboring countries. The simulation which considered India as the "fourth" country showed that such cooperation would still significantly reduce the required stocks that will be beneficial for all member countries involved. India was emphasized in the simulation because of its important role in the region. The fact that the country is home to around 200 million undernourished people[17] has brought serious concerns to the policymakers in the country. With the world's largest food programs covering public procurement, storage, and distribution of wheat and rice, India has successfully stabilized its food prices for many years. However, the policies give rise to very high fiscal cost. In 2013, the cost is estimated to be around 1.2 % of the country's GDP (Kozicka et al. 2015).

While India is not part of ASEAN Plus Three countries food reserve cooperation, ASEAN and India have already signed an FTA, which has been in force since January 2010. The countries involved could also consider including food reserve as part of their cooperation which will likely be beneficial to all the participating countries. In addition to reducing the overall fiscal costs, larger cooperation and coordination also mean that collective action failures are diminished.

Learning from ASEAN case, public food reserve is an ancient idea that is still relevant today. The way forward is to build institutional arrangements that facilitate coordination and cooperation among countries through various channels, including the multilateral trading system of the WTO. Each of the ASEAN trade agreements with six countries[18] which could be deepened under the RCEP framework, which combines all ASEAN "plus" agreements together, and this could be a starting point for a stronger and larger cooperation in various areas, including public reserves.

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Appendix

[17]Estimated from 17 % of population as stated in the Global Hunger Index, IFPRI et al. (2014).

[18]The six countries are Australia, China, India, Japan, Korea, and New Zealand.

Table 17.8 Correlation of supply shortfalls from target consumption of 97 %

	BRN	KHM	IDN	LAO	MYS	MMR	PHL	SGP	THA	VNM	CHN	JPN	KOR
BRN	1												
KHM	−0.0124	1											
IDN	−0.1529	0.0534	1										
LAO	−0.0805	−0.0614	0.3666*	1									
MYS	0.1322	0.1505	0.0084	0.15	1								
MMR	−0.2106	0.0689	0.1542	0.1115	0.6032*	1							
PHL	0.0871	−0.0514	−0.0697	0.0825	0.0027	−0.1111	1						
SGP	−0.1477	0.3081	−0.1211	−0.1792	−0.1117	−0.1291	0.0638	1					
THA	−0.1184	−0.1699	0.0066	0.0013	−0.0322	−0.0356	0.4060*	0.3721*	1				
VNM	−0.1455	−0.1263	−0.0643	−0.1139	−0.0923	−0.1028	−0.0728	0.0142	0.0815	1			
CHN	0.4617*	−0.0895	−0.0635	−0.1097	0.2073	−0.0577	−0.072	0.0488	0.1212	−0.0664	1		
JPN	0.0248	−0.0494	0.224	0.5026*	−0.0518	−0.1373	−0.0028	−0.1397	−0.0782	−0.0897	0.2056	1	
KOR	0.2939	0.0595	−0.0642	−0.0528	0.5680*	0.109	−0.0374	−0.194	−0.1071	−0.1088	0.5560*	0.0391	1

Source: Own calculation based on USDA PSD. *Note*: *BRN* Brunei Darussalam, *KHM* Cambodia, *IDN* Indonesia, *LAO* Lao PDR, *MYS* Malaysia, *MMR* Myanmar, *PHL* Philippines, *SGP* Singapore, *THA* Thailand, *VNM* Vietnam, *CHN* China, *JPN* Japan, *KOR* Rep. Korea

* represents significance level at 95 %

Table 17.9 Rice supply, consumption, and shortfall 1980–2014

	Supply		Consumption		Shortfall		
	Annual average (000 tons)	Regional share (%)	Annual average (000 tons)	Regional share (%)	Number of shortfall	Maximum shortfall (000 tons)	Mean of shortfall (000 tons)
ASEAN							
Brunei	31.7	0.01	31.71	0.01	14	7.36	1.27
Cambodia	2494.63	0.80	2213.09	1.00	9	286.61	36.52
Indonesia	37, 250.69	11.94	32, 765.20	14.84	3	344.48	15.57
Lao PDR	1089.40	0.35	1057.20	0.48	9	113.47	11.35
Malaysia	2327.60	0.75	1926.37	0.87	7	107.68	6.92
Myanmar	10, 019.80	3.21	8751.66	3.96	7	207.31	19.50
Philippines	10, 958.83	3.51	8685.11	3.93	6	470.13	23.72
Singapore	271.86	0.09	268.60	0.12	11	62.52	7.09
Thailand	18, 737.71	6.01	9079.97	4.11	6	780.79	66.28
Vietnam	19, 028.09	6.10	15, 135.54	6.85	3	819	39.41
Plus Three							
China	191, 979.50	61.56	126, 655.20	57.35	4	4069.61	180.69
Japan	11, 315.51	3.63	9118.14	4.13	7	793.68	50.65
Rep. Korea	6352.40	2.04	5171.37	2.34	6	358.73	41.60
Total	311, 857.73	100	220, 859.17	100	92	8422.30	500.57
Regional	311, 857.73	100	220, 859.17	100	31	4725.21	506.43

Source: Own calculation based on USDA PSD. *Note*: Regional refers to ASEAN Plus Three countries as a region

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When Do Prices Matter Most? Rice, Wheat, and Corn Supply Response in China

18

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18.1 Introduction

Unexpected high and volatile food prices during the 2007–2008 world food crisis and thereafter have reemphasized the question of how countries can protect themselves from supply shortages. In view of the various trade restrictions imposed by some major exporting countries, governments tend once again to focus more on self-sufficiency and food storage. Additionally, emerging economies like China aim at increasing their yields. This is because the possibilities of expanding agricultural land are limited, while population, total grain demand, and meat consumption are rising.

The primary purposes of analyzing the supply response are threefold in this chapter. First, this work aims to identify the different factors that can affect production, such as market prices, biophysical conditions, and infrastructure. The second objective is to analyze the differences in the effects of these factors on the different crops. The third aim is to evaluate how the predictive power of prices evolves over time and therefore to understand when farmers react most strongly to prices. Hence, a clear understanding of the farmers' planting and production behavior is needed.

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In the context of empirical estimations, farmers' decision-making is generally modeled as a two-step process (Colman 1983): First, farmers choose the crop type based on past weather conditions and decide their cropping area based on the prices they expect to receive several months later. Second, after planting, they change their farmland management measures according to market prices and weather condition to achieve a high yield. We focus on the production response of winter wheat, indica rice, and corn as these crops are the main staple foods in China. China is the biggest producer of rice and wheat and one of the biggest producers of corn. The results of the research can also be used as the basis for a short-term forecasting tool for monitoring Chinese food security or as part of a worldwide food availability monitoring tool. However, forecasting would require timely availability of data, which usually is not possible for data from the Chinese Agricultural Yearbooks.

In China, early works in this field have focused on the roles of price and marketing reforms in agricultural production (e.g. Lin 1991). Empirical studies have found a positive impact of price changes on output during the first years of reform (Lin 1992; Huang and Rozelle 1996). Lin (1992) found that 15 % of output growth in 1978–1984 came from the rise in relative prices. Huang and Rozelle (1996) showed about 10 % of rice output growth between 1978 and 1984 was caused by price effects. The gains have also resulted from increased allocative efficiency through market liberalization since the early 1990s. For example, de Brauw et al. (2004) showed that increasing marketization had a positive effect on crop allocation and productivity. The recent works have paid more attention to the impacts of subsidizing agriculture after China shifted its agricultural policy from taxing farming households to providing them with subsidies in 2004. While these subsidies are given to all producers and are very high, even higher than in the USA and the EU on a per unit area basis in 2012, they are quite low on a per household or per farm basis as farms in China are mostly of small scale (Huang et al. 2013). Except for subsidies for machinery, which influenced the purchase of machineries, most other subsidies for grain, input, and seed were found not to influence farmers' area allocation decisions (Huang et al. 2011). This finding provides the rationale behind not explicitly including subsidies in this study. Increased grain outputs in the later years were partly attributed to land reallocation to grain production (Yu and Jensen 2010). With the help of a dynamic panel approach, acreage and yield responses to output prices were analyzed in a case study for Henan (Yu et al. 2011). Both area and yield were found to be price-responsive. However, evidence from other provinces is missing, and the effects of high temperatures have not been addressed. This chapter focuses on both of these issues. Furthermore, the role of prices at different points in time is at the heart of this analysis. At the global level, price volatility and therefore price risks were found to reduce the supply response (Haile et al. 2016). However, as prices are comparably stable in China, price volatility was not considered as an important factor in this study.

In the face of global warming, interest in its impacts on agriculture is increasing. The impacts of climate change are expected to be huge and have already been partly documented. The general findings include an expected decline of crop yields in China, as in other developing countries (Tao et al. 2006). By employing farm-

level data and the Ricardian method, the average impact of higher temperatures was found to be negative, whereas the average impact of more rainfall was found to be positive (Wang et al. 2009). Overall, weather conditions, market prices, and infrastructures can be seen as the three most important conditions for agriculture production. This study makes an important contribution to evaluating how such weather-related variables, especially high temperatures, affect the production of the considered crops at the province level. Furthermore, to our knowledge, this is the first study which addresses the production response to prices at different periods in time in order to analyze the farmers' price expectation formation process.

The next four sections present the data, methods, results, and conclusions, respectively.

18.2 Data Description and Usage

Data on acreage, production, output market prices, procurement prices, fertilizer prices, rainfall, consumer price index (CPI), irrigated area, temperatures, sunshine, effective irrigated area, and prices of competing crops were collected from the Chinese agricultural and statistical yearbooks from 1996 to 2012. Province-level data was used whenever possible, but whenever such data was scarce, national-level data was used instead. Own crop prices were deflated by the CPI; other prices were deflated by the own crop price, resulting in relative prices to take into account any possible correlation. Table 18.1 provides an overview of the aggregation level, frequency, and transformations of the data. The summary statistics of the variables are presented in Table 18.2 for the individual crops.

A panel data set was created for each crop, whereby the province-wise production of a crop was used as the dependent variable to be explained by the other variables. The provincial production data, collected from the National Bureau of Statistics of China, was collected from 1995 to 2012 and includes information on 20 provinces planting winter wheat, 29 provinces planting corn, 13 provinces planting early and late indica rice, and 15 provinces planting middle indica rice. For indica rice, data from the early, middle, and (double) late seasons were pooled together to get more observations and hence ensuring that the number of observations did not fall below 249. However, this came at the cost of not being able to detect any heterogeneity in the response which cannot be captured by the fixed effects.

The planting season and complementing and substituting crops may differ slightly among the different provinces. For winter wheat, the planting season is from September to October, and its harvesting takes place in the late April or May of the following year. The main substitute is rapeseed, followed by cotton, while corn is a complementing crop. Corn is mainly planted from April to June and harvested between August and October. The main substitutes are soybean and cotton, and the main complementing crops are wheat and rapeseed. Based on the farmers' production behavior, we focused on input and output prices, weather conditions, and infrastructure. For crop prices, monthly wholesale prices were used. This is because wholesale prices were more easily available than farm gate prices and also

Table 18.1 Overview of the data used for the regression analysis

Data	China ... yearbook	Scale	Frequency	Transformation
Production	Rural statistic	Province	Yearly	Logged
CPI	Statistical	Province	Monthly	Continuous CPI build from yearly changes
Total farm crop area	Rural statistic	Province	Yearly	–
Irrigated area	Water conservancy	Province	Yearly	Divided by total farm crop area and logged
Nonirrigated area	–	Province	Yearly	log(1-irrigated area/total farm crop area)
Wholesale prices	Grain	National	Monthly	Divided by continuous CPI and logged (for competing crop prices: divided by own crop price)
Fertilizer prices	Price	National	Monthly	Divided by wholesale price and logged
Rainfall	Water conservancy	Province	Monthly	Logged
Hours of sunshine	1	Province	Monthly	Logged
Lowest temperature	1	Province	Monthly	–
Average temperature	1	Province	Monthly	–
Highest temperature	1	Province	Monthly	–
Area affected by drought	Water conservancy	Province	Yearly	Divided by total farm crop area and logged

Note: The second column shows the source, i.e., from which of China's yearbooks the data is taken. 1 means that it is not taken from any yearbook but from the National Meteorological Information Center of China

because of the high transmission from wholesale to farm gate prices, as reported in the literature (Liu et al. 2012).

As land and labor are limited, planting behavior can be affected by the price of competing crops. Fertilizer prices were chosen as the main input market price. Wages, obtained from Bloomberg, were also included, but their time series is short and as a result so is the number of observations. Due to this and the fact that they turned out to be insignificant, they were not reported in this chapter but are available upon request. The agricultural production system is sensitive to weather effects, and there are very few measures available to farmers to compensate for weather effects. Therefore, weather conditions, collected from the National Meteorological Information Center of China, were a very important independent variable in this analysis. The percentage share of cultivated area under irrigation can also be seen as a measure of infrastructure and technology. Missing values for this variable, but not for any other variables, were imputed. Irrigation also allows farmers to compensate for insufficient rainfall and partly even droughts. As irrigation is typically used in combination with the application of chemical fertilizers, it represents a higher standard of agricultural infrastructure. However, irrigation relates to the cultivated land area under irrigation and hence is not crop specific. As a result, only very

Table 18.2 Summary statistics of the data from all provinces

	Obs	Mean	SD	Min	Max
Corn					
Production (1000 tons)	552	458.7	549.5	0.9	2675.8
June WSP (CNY/kg)	463	1.4	0.4	0.9	2.3
Irrigation (1000 ha)	552	1813.9	1385.8	144.2	5205.6
Rainfall @ growing (cm)	534	14.1	6.8	1.5	40.4
Average temp @ growing (°C)	534	24.9	3.3	13.2	30.7
Drought area (1000 ha)	495	448.1	544.2	1.0	3133.0
Fertilizer price (CNY/kg)	492	1916.4	672.6	1186.0	3140.0
Winter wheat					
Production (1000 tons)	360	464.3	686.8	0.2	3177.4
March WSP (CNY/kg)	301	1.5	0.4	1.0	2.2
April's sunshine hours	360	5.6	1.8	1.7	9.4
Irrigation (1000 ha)	360	2041.9	1466.8	173.6	5205.6
Rainfall @ growing (cm)	360	6.0	4.8	0.2	22.4
High temp @ flowering (°C)	360	26.0	4.1	16.6	37.3
Rainfall @ planting (cm)	360	2.9	1.6	0.1	11.7
Drought area (1000 ha)	321	399.5	482.9	1.0	2573.0
Fertilizer price (CNY/kg)	320	1897.8	665.3	1184.0	3000.0
Indica rice					
Production (1000 tons)	707	406.1	433.0	0.0	2161.1
WSP @ planting (CNY/kg)	594	1.5	0.4	0.9	2.5
Sunshine hours @ planting	707	5.4	1.4	2.1	10.4
Irrigation (1000 ha)	707	1751.3	985.5	169.9	3929.7
Rainfall @ growing (cm)	707	11.4	4.3	2.6	26.2
Rainfall @ planting (cm)	707	3.8	2.6	0.1	19.5
High temp @ growing (°C)	707	33.7	2.0	27.2	39.7
Drought area (1000 ha)	639	292.9	361.0	1.0	2250.0
Fertilizer price (CNY/kg)	632	1867.1	668.0	1126.0	3340.0

Note: Data which is only available on a national basis has been copied for all provinces and therefore is shown to have more observations than it actually has on the national level. Data is only reported if the value for production for that crop, year, and province is available. Unless the month is indicated, the @ is used to specify time periods

limited conclusions can be drawn about how irrigation affects production. This is discussed further in Sect. 18.4 and also applies to the drought area, which is also not crop specific.

As some of the weather data has a high level of autocorrelation, it is not possible to consider every month in the econometric analysis. Therefore, only the most important month is included, except for rainfall, in which case the sum of the most important months is calculated. The hypotheses to test in this chapter are as follows: (1) A positive response to own output prices, and a negative response to competing crop prices as well as fertilizer prices, at least if the crop has a higher fertilizer

requirement than competing crops; (2) own output prices matter most in the time period from shortly before to a few month after planting, during which farmers make their decisions on areas and yields; (3) droughts and insufficient rainfall have a negative effect on production; (4) irrigation has a positive impact and can reduce the negative impact of insufficient rainfall or high temperatures.

This approach has some limitations. The biggest limitation might be the aggregation level of data. Some price data were only available at a national level, but as price transmission within China is high (Huang and Rozelle 2006), this might not be a concern. For the biophysical variables, even though they were available at the provincial level, this aggregation might be more problematic as rainfall, hours of sunshine, and temperatures may vary in different parts of the same province. Therefore, the influence of these biophysical variables is likely to be underestimated due to this high level of aggregation. Furthermore, important variables may not be considered which could be an issue if they fluctuate a lot in the short term. If they mostly consist of a long-term trend instead, then they will be captured by orthogonal deviations and lagged production and, as a result, will not cause any problems.

18.3 Methodology

Strictly speaking, a farmer's decision-making process consist of two steps: the area decision and the yield decision (Colman 1983). The considered determinants are mostly the same but may differ slightly as, for example, competing crop prices are not that important after the area decision was made. However, they still may be important because they may affect how farmers allocate their inputs such as fertilizers, pesticides, and water and other variables. On the other hand, not all variables which influence yields also matter when allocating the area. Unexpected rainfall shocks (or price shocks) after planting cannot be anticipated and therefore cannot affect the area decision. However, these shocks may affect a farmer's fertilizer application and therefore yield. Therefore, modeling production is a combination of the area and yield processes and can only be investigated by considering the sum of both effects. Nevertheless, it is important to see the combined effects as we are interested in the total production volume and want to know which variables have an influence and how the variables influence. Another reason to look at the combined effect on production is that statistical issues arise when looking at area and yield separately. This is because area and yield influence one another, and therefore this additional endogeneity has to be dealt with. For example, area allocation decisions may affect yields in two different ways: High prices could cause farmers to favor large planting areas, which should increase the expected yields, whereas planting area expansion may negatively influence yields if the additional crop areas are located on less-productive lands.

The Arellano–Bond difference GMM and system GMM estimators (Holtz-Eakin et al. 1988; Arellano and Bond 1991; Arellano and Bover 1995; Blundell and Bond 1998) were used for a number of reasons. First, the time period was rather short, usually around 14 years, while the number of observations per time period was

comparatively large: 20 for wheat, over 29 for corn, and around 40 for rice. The difference GMM and system GMM estimators control for such dynamic panel bias. Second, the production response is a dynamic process, i.e., current realizations depend on past ones. Third, fixed effects allow for heterogeneity across groups, namely provinces. Last, idiosyncratic disturbances may have individual-specific patterns of heteroskedasticity.

For all three crops, four different specifications are shown in the tables in Sect. 18.4, with the first three presenting different control variables for the difference GMM estimator and the fourth illustrating the results for the last specification using the system GMM estimator for comparison and robustness checks. While including more variables allowed more factors to be controlled for, it also decreased the degrees of freedom, the significance of variables which are correlated and most importantly the number of observations (because many variables could only be obtained for a limited number of years). Comparing the different specifications and comparing the difference and system GMM results provide a further consistency check. In general, we think that the difference GMM estimator is more appropriate as it cannot be ruled out that the first differences of the instrument variables are uncorrelated with the group fixed effects. Our findings support this hypothesis, as will be shown in the next chapter. The Windmeijer finite-sample correction for standard errors was used (Windmeijer 2005). We used the xtabond2 command in Stata, which was written by David Roodman, and followed the application guidelines in his accompanying paper (Roodman 2009). Instead of first differencing, forward orthogonal deviations were used (Arellano and Bover 1995; Roodman 2009), i.e., the average of all available future observations was subtracted. This procedure removes fixed effects, just like differencing, but because lagged observations are not used, these remain orthogonal to the transformed errors. This way, the number of observations will not be reduced by gaps in the dataset. As suggested, time dummies for all years were included in all model specifications (ibid).

For proper usage of the GMM techniques, a number of tests need to be run to check the consistency of the estimations (ibid.; Efendic et al. 2009). The joint significance of the variables was evaluated with an F-test, the p-value of which we expected to be clearly below 0.1 (ibid.). While the first lagged residuals are expected to be correlated, the twice lagged residuals must not (Arellano and Bond 1991). Considering the null hypotheses, this means the p-value of the AR1 test in the result tables was expected to be smaller than 0.1, while the p-value for the AR2 test should be higher than 0.1 (for significance at the 10 %-level). Furthermore, the Hansen-J test allows checking if the model specification and all over-identifying restrictions are correct (Baum 2006). It is suggested that the p-value should be above 0.25 but at the same time should not perfectly match 1 for this test (Roodman 2009). The difference-in-Hansen test was used to investigate the exogeneity of instruments. The null hypothesis is that they are exogenous. Hence, the respective p-values have to be above 0.1 in order to not reject the null hypothesis. The number of instruments was chosen to provide robust test statistics. There are no clear rules about the appropriate number of instruments. However, the number of instruments should always clearly be lower than the number of observations, which is the case for all our specifications.

Furthermore, the coefficient of the lagged endogenous variable (production in our case) should be less than one to obtain a steady state behavior (Roodman 2009), which is the case in all of the presented models. Finally, the validity of the estimates can be verified by examining if the coefficient of the lagged dependent variable is larger than the one obtained by a fixed effects model and smaller than one obtained by using OLS (Bond 2002). This was the case for all specifications and the FE and OLS estimates of the lagged dependent variables are reported in the tables.

All the test statistics were fulfilled in all specifications except for two instances: (1) the first specification for winter wheat, which failed to reject the second order autocorrelation at the 10 % level but nevertheless did so at the 5 % level; and (2) the first specification for indica rice, which failed to reject the Hansen-*J* test and the difference-in-Hansen test.

Apart from evaluating the production response using the price at a predetermined point in time, this work aims at analyzing how production responds to prices at different points in time. Therefore, the regressions were conducted with prices at different months before and after planting, from 20 months before up to 20 months after planting, and how this changes the results is graphically illustrated. For this analysis, the second specification is used for all crops as this specification provides the maximum number of observations while fulfilling all test criteria and while including the most important variables. This procedure allowed us to analyze how farmers build their price expectations, in particular whether they used previous year's prices around planting or harvesting time or if they used the latest prices which, under the assumption of efficient markets, incorporate all available information about supply and demand.

For indica rice, data for the three different seasons were pooled together. Hence, there is no fixed planting month, but the appropriate planting month was chosen depending on the season instead. All the other variables were similarly chosen relative to the month of planting for that season. This means, for example, that the planting time price is April for early indica, May for middle indica, and July for late indica rice. Similarly, rainfall during the growing season refers to April and May for early indica, May and June for middle indica, and July and August for late indica rice.

All variables were logged, and therefore the effects can be interpreted as elasticities. The only exception are temperatures, which also exhibited negative values and are more intuitive to interpret in their non-logged form.

18.4 Results

18.4.1 Basic Regression Results

The results for the production of corn are shown in Table 18.3, for winter wheat in Table 18.4, and for indica rice in Table 18.5. The first row always shows the lagged production. Wholesale prices are denoted by WSP followed by the month or relative time period. The latter are always denoted by the @ symbol and refer to

Table 18.3 Results for corn production response

	(1)	(2)	(3)	(4)
L. Production	.807***	.772***	.902***	.956***
	(.166)	(.143)	(.139)	(.034)
WSP June	.296***	.291***	.226***	.177***
	(.077)	(.055)	(.065)	(.05)
Irrigated	−.115	20.1**	16.8**	1.61
	(.131)	(8.12)	(8.07)	(6.65)
Rain @ growing	−.059	−.013	−.076	−7.4e−03
	(.063)	(.06)	(.08)	(.033)
A-Temp @ growing	−.029*	−.095***	−.058*	−.014
	(.015)	(.026)	(.029)	(.024)
Drought area	−.032***	−.033***	−.035***	−.014
	(8.6e−03)	(9.1e−03)	(.01)	(.013)
Nonirrigated X rain @ growing		.077*	.071*	.066***
		(.045)	(.037)	(.021)
Irrigated X A-temp @ growing		−.067**	−.052*	−5.3e−04
		(.027)	(.027)	(.023)
Fertilizer @ planting			−.203**	−.231***
			(.074)	(.065)
Irrigated X fertilizer @ planting			−.182**	−.191***
			(.068)	(.058)
Substitute @ planting			.018	6.3e−03
			(.027)	(.017)
Constant				6.29
				(6.9)
Estimator	Difference	Difference	Difference	System
Groups	29	29	29	29
Instruments	27	29	28	30
p:*F*-test	1.7e−19	1.3e−23	1.1e−27	4.0e−37
p:AR1	1.5e−03	1.1e−03	9.9e−04	3.2e−04
p:AR2	.919	.685	.949	.581
p:Hansen-*J*	.291	.326	.286	.535
p:Diff-Hansen	.812	.9	.436	1
OLS	.988	.991	.985	.985
FE	.741	.683	.747	.747
Observations	384	384	296	325

Note: Standard errors in parentheses. WSP: wholesale price; X indicates interaction terms; A-temp: average temperature; specifications with different explanatory variables for the difference GMM estimator (1–3); for comparison and robustness checks, the results of the last specification are also shown for the system GMM estimator (4)
$p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 18.4 Results for winter wheat production response

	(1)	(2)	(3)	(4)
L. Production	.951***	.951***	.96***	.964***
	(.104)	(.11)	(.087)	(.063)
WSP March		.338***	.292**	.255*
		(.116)	(.132)	(.143)
H-temp @ flowering	−.043***	−.044**	.061	−.037
	(9.6e−03)	(.019)	(.123)	(.122)
Sun @ flowering	.156	.081	.124	.196
	(.092)	(.205)	(.207)	(.293)
Rain @ planting	.054**	.045	.04	.047
	(.021)	(.026)	(.042)	(.037)
Rain @ growing	3.5e−04	−.045	−.143	−.133
	(.032)	(.037)	(.099)	(.091)
Irrigated	−.055	−.344	−31.9	−.093
	(.483)	(.478)	(37.2)	(26.4)
Drought area	−.037**	−.026	−.034	−.026*
	(.014)	(.016)	(.02)	(.014)
Nonirrigated X rain @ growing			−.137	−.177
			(.135)	(.165)
Irrigated X H-temp @ flowering			.105	−1.1e−03
			(.125)	(.089)
Constant				10.3
				(36)
Estimator	Difference	Difference	Difference	System
Groups	20	20	20	20
Instruments	26	25	27	29
p:*F*-test	1.4e−13	2.0e−12	2.0e−14	1.8e−22
p:AR1	8.8e−03	.019	.012	.016
p:AR2	.053	.185	.173	.241
p:Hansen-*J*	.595	.463	.805	.744
p:Diff-Hansen	.949	.847	1	1
OLS	1.01	1.02	1.02	1.02
FE	.865	.855	.863	.863
Observations	280	249	249	269

Note: Standard errors in parentheses. WSP: wholesale price; X indicates interaction terms; H-temp: high temperature; specifications with different explanatory variables for the difference GMM estimator (1–3); for comparison and robustness checks, the results of the last specification are also shown for the system GMM estimator (4)
$p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 18.5 Results for indica rice production response

	(1)	(2)	(3)	(4)
L. Production	.913***	.914***	.778***	.911***
	(.07)	(.055)	(.112)	(.081)
WSP @ planting	.196***	.181***	.163**	.241**
	(.067)	(.054)	(.061)	(.094)
Rain @ growing	.053*	.152	.115	.425
	(.027)	(.139)	(.178)	(.284)
Sun @ growing	.174***	.167***	.142*	.023
	(.061)	(.05)	(.074)	(.117)
H-temp @ growing	−.024**	−.026***	−.039***	.019
	(.01)	(8.5e−03)	(.013)	(.03)
Irrigated		.356	.323	1.06
		(.521)	(.674)	(.731)
Nonirrigated X rain @ growing		.294	.262	.691
		(.287)	(.346)	(.495)
Drought area		−4.9e−03	−1.4e−03	4.6e−03
		(8.8e−03)	(8.0e−03)	(.012)
Fertilizer @ planting			.032	−.048
			(.078)	(.058)
Substitute @ planting			.018	.04
			(.032)	(.048)
Constant				−4.51
				(9.08)
Estimator	Difference	Difference	Difference	System
Groups	41	39	39	39
Instruments	20	23	22	24
p:*F*-test	2.8e−16	3.2e−20	1.2e−15	1.0e−22
p:AR1	.073	.098	.118	.096
p:AR2	.174	.171	.142	.138
p:Hansen-*J*	.153	.341	.409	.24
p:Diff-Hansen	.088	.102	.227	.569
OLS	.997	.998	.994	.994
FE	.727	.722	.551	.551
Observations	548	503	394	433

Note: Standard errors in parentheses. WSP: wholesale price; X indicates interaction terms; H-temp: high temperature; specifications with different explanatory variables for the difference GMM estimator (1–3); for comparison and robustness checks, the results of the last specification are also shown for the system GMM estimator (4)
$p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

the planting, growing, flowering, or harvesting season of the crop. Average and high temperatures are written as A-temp and H-temp, respectively. Interaction terms are indicated by an X, while the prices of competing crops are presented as substitute. The bottom part of the tables shows which estimator was used; the test statistics; and the number of groups, instruments, and observations.

The results for corn, illustrated in Table 18.3, show that all specifications seem to be valid based on the provided test statistics. A significant amount of variation in production can be explained by the previous year's production (which also takes into account unobserved variables). The coefficient ranges from 0.772 to 0.956 and is significant at the 1 % level in all specifications. The wholesale price in June turned out to be also always highly significant and had a major contribution, as evident in its elasticity of around 0.2. This implies that a 1 % increase in prices will lead to a 0.2 % increase in production, which seems reasonable and is comparable to the results obtained by similar studies. The fraction of irrigated area is only significant in two specifications but has a huge impact in both. However, it is only significant for the difference GMM specifications that included the interaction terms, which could possibly be attributed to collinearity in these variables (their correlation coefficient is -0.79 for corn, -0.17 for wheat, and -0.46 for rice). In addition, the total effect of irrigation is the elasticity of irrigation plus the interaction term of irrigation with the average temperature. The interaction term takes the value of -20.69 at the sample mean for the second specification, resulting in a combined marginal effect of -0.59. Despite corn needing rainfall during the growing season, the rainfall variable did not seem to have any significant effect on the corn production. However, corn needs little water compared to other staples and in particular vegetables. As mentioned in Sect. 18.2, the irrigation variable measures the total cultivated area under irrigation. This may not be a good proxy for the actual irrigated crop areas; in particular, it is not a measure of crop-specific irrigation. Furthermore, the quality of irrigation is not reflected in this variable. Moreover, considering rainfall variability and water availability, the quality of irrigation may change drastically over time. Therefore, the influence of irrigation can only be approximated, and thus it is unsurprising that no effect was found in many of the specifications (when compared with wheat and rice).

High average temperatures during the growing season, which is in mid-summer, have a small but significant negative impact. When interacted with the nonirrigated area (i.e., the fraction of the agricultural area which is not irrigated), we found that rainfall during the growing season became significant. As expected, rainfall had a positive influence on production, albeit a small one. When interacted with irrigation, high average temperatures are negative and significant for the difference GMM specification. This differs from our expectations but might be explained by the imprecise approximation of irrigation or by high temperatures offsetting the benefits of irrigation. As expected, the drought area had a significant and negative influence in all but the system GMM specifications. High fertilizer prices at planting time reduced the total production; again, this effect seems to be more pronounced in provinces with a high share of irrigated area. This may be attributed to the fact that levels of fertilizer application are usually much higher on irrigated areas, which

may therefore be over-proportionally affected. Prices of competing crops turned out to be insignificant, despite testing various ways of including them in the analysis, such as using the province-specific main competing crop only or a weighted average of competing crops.

For winter wheat, presented in Table 18.4, the previous year's production was again the most important driver and consistently significant at the 1 % level. Wholesale prices in March had a similar positive and significant effect, as for corn. The elasticity is around 0.29, even slightly higher than for corn. The first specification did not include any prices to ascertain if there are any changes when more observations are included. This is because the number of observations for winter wheat is relatively low compared with corn and rice. The amount of sunshine at flowering (around two months before harvesting) is insignificant. From the literature, wheat is expected to require much sunshine during this period (FAO 2015). Furthermore, much rain is needed during and shortly after planting as well as during flowering and yield formation (ibid.). The positive influence of rainfall during and after planting can be observed in the first specification only. Rainfall during the growing season and its interaction term with the nonirrigated area are always insignificant. This might be a result of data aggregation, as explained above. The irrigated area seems to have no effect, but this may be attributed to the poor approximation of irrigation, as explained above. The drought area has a significant negative impact in two specifications, again albeit with a very small effect. The expected negative effect of overly high temperatures during flowering time vanished once the interaction term with irrigation is included. Then, both terms became insignificant. Fertilizer prices and prices of competing crops had no significant effect but reduced the number of observations significantly. Therefore, they are not shown separately but are available upon request.

Similar to corn and wheat, lagged production was the most important driver of indica rice production, as illustrated in Table 18.5. The effect of the wholesale price is similar to the case of corn; it was always significant and had an effect size of around 0.2. Rain during the growing season, a large amount of which is required to flood rice paddy fields, was positive but only significant at the 10 % level in one specification. But as explained before, this might be a result of aggregating rainfall data across the provincial level. The results did not change when we included squared rainfall. Even when interacted with the nonirrigated area, the rainfall stayed insignificant. The irrigated area itself is insignificant, which, as detailed before, might be attributed to the poor proxy used for irrigation. For sunshine, we found that a 1 % increase in the number of hours of sunlight increased the production by around 0.16 % in all the difference GMM specifications. Similarly, the damaging effect of overly high temperatures during the growing season can be observed in all difference GMM specifications. The drought area, fertilizer prices, and the prices of competing crops all turned out to be insignificant. The underlying reasons might be that the costs of switching crops from rice are relatively high and that rice needs a comparatively small amount of fertilizer per unit of output.

Overall, our results were mostly comparable to other similar studies. In a non-crop specific analysis, Ghatak and Seale (2001) found that price elasticity was between 0.174 and 0.394, which is similar to ours. Looking only at the national level, own price elasticities of 0.23 for rice, 0.052 for wheat, and 0.164 for corn have been reported (Haile et al. 2015). Our results for rice and corn were comparable, whereas we found a higher price response for wheat. For Henan, Yu et al. (2011) found no significant response for wheat but a surprisingly high elasticity of 0.737 for corn. However, according to the study, the elasticities of competing crop prices were also high and significant. They also reported that rainfall increased winter wheat production when considering the total effect on area and yield. For corn, they found that rainfall had no effect, which is consistent with our results if only the non-interacted rainfall is considered, as in the study by Yu et al.

18.4.2 Impact of Prices on Production During the Marketing Year

As explained in Sect. 18.3, one of the aims of this chapter is to analyze how production reacts to prices at different points in time. Therefore, the regressions with same specifications were run for prices at different months before and after the planting time. For all other variables, the values used remain the same as before. The results are depicted in Fig. 18.1 for corn, in Fig. 18.2 for winter wheat, and in

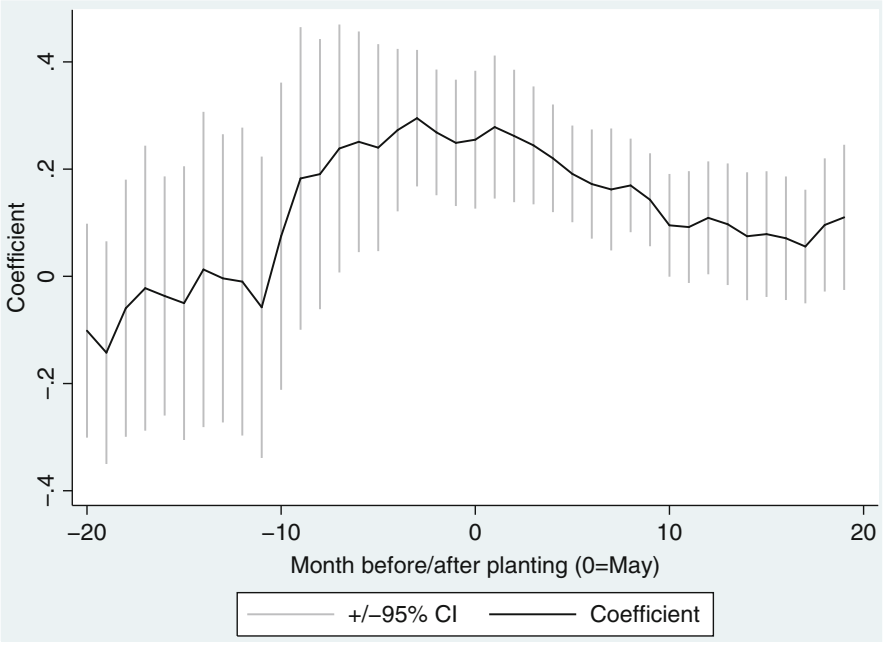

Fig. 18.1 Explanatory power of the wholesale prices over time for corn production

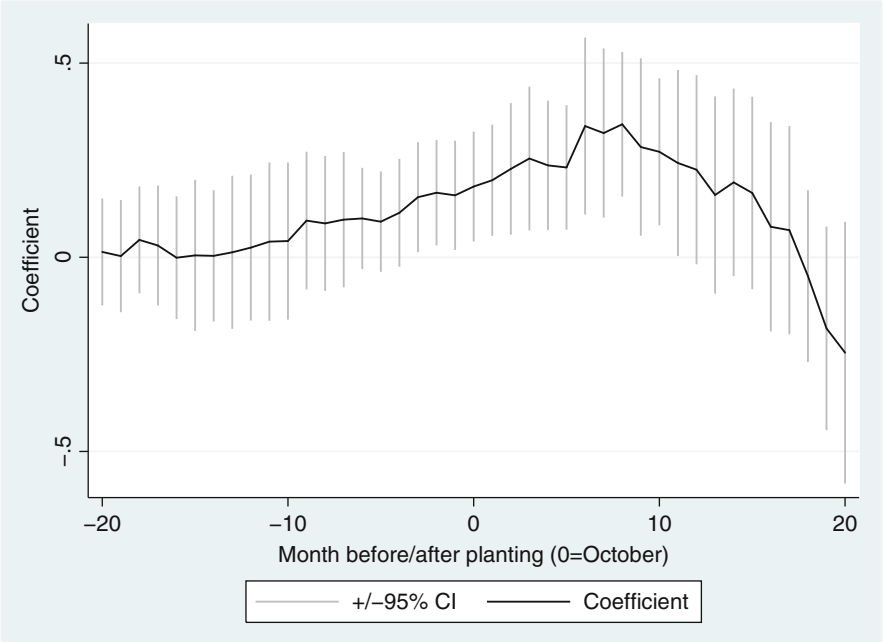

Fig. 18.2 Explanatory power of the wholesale prices over time for winter wheat production

Fig. 18.3 for indica rice. The figures show the coefficients and the 95 % confidence intervals; the statistical significance of the response can be inferred from the figures. The further the distance between the bars and the $y = 0$ line, the higher the level of significance. If the $y = 0$ line is included in the bars, the coefficient is not statistically significant at the 5 % level. The months before or after planting are depicted on the x-axis of the graphs.

Prices far before or after planting did not have much explanatory power for all crops; hence they do not influence production strongly. However, prices around planting time are usually highly significant and, at least for corn and rice, also have the highest coefficient. For rice, prices are significant in a few months far before planting, which may be attributed to the high level of autocorrelation. Nevertheless, both the level of significance and the coefficient increased and reached their highest level around planting time. Both rice and corn have a relatively short growing time—about 2–6 months—compared to wheat. This explains why prices during planting period were very important as farmers chose their area and had only little time afterwards to influence yields. Particularly for rice, the beginning of the growing season is highly important and a lack of water cannot be compensated for at a later stage. The finding of a decreased level of significance and lower coefficients a few months after planting is therefore consistent with our expectations. For wheat, the graph looks different: the level of significance as well as the size of the coefficient increased even after planting and reached their highest levels around 6–8 months

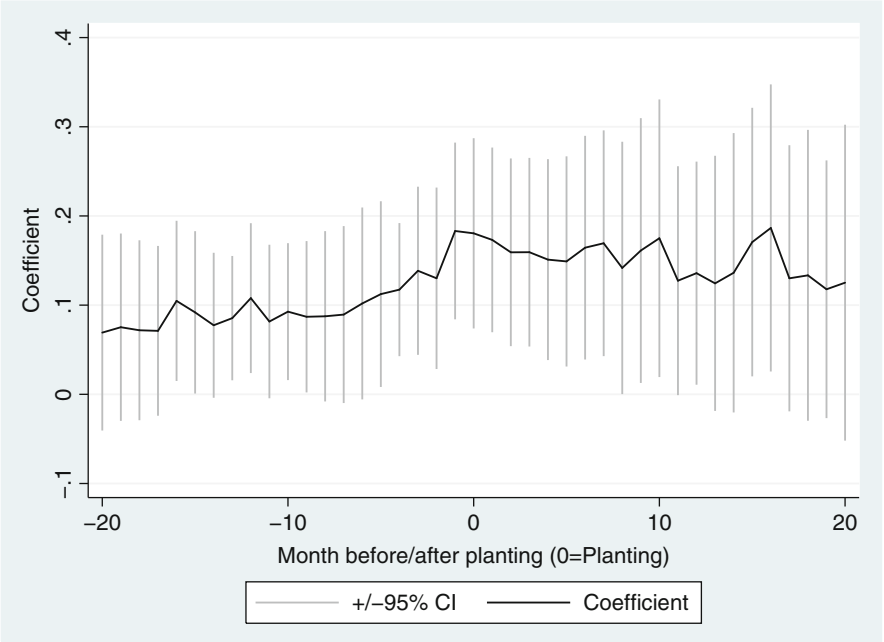

Fig. 18.3 Explanatory power of the wholesale prices over time for indica rice production

after planting. This can be explained by the different growing patterns, i.e., wheat grows for about 7–9 months after it is planted. Furthermore, the most sensitive phase of the crop is the flowering and yield formation period, whereby the wheat plant is very sensitive to water and temperatures (FAO 2015). This period is around 65–15 days before the harvest. As a result, it is crucial how farmers take care of their crops during this time period, while the establishment, tillering, and winter dormancy periods are of minor relevance (ibid.). Considering this, it matches our expectations that prices around 6 months after planting are very important for yield. For area however, prices at planting time should be the crucial factor. Although without making a distinction between area and yield, it is not possible to draw further conclusions about this.

Comparing the different crops, we found that farmers seem to react earlier to corn prices than the prices of winter wheat and indica rice. Rice showed the lowest response to prices, which might be a result of relatively high costs of area reallocation. For all crops, prices remained highly significant for a while after planting. This indicates that not only area but also yield respond to prices, regardless of whether it is due to fertilizer or pesticide application, irrigation, or other factors. For prices at harvesting time and thereafter, this method suffers from endogeneity problems as it is no longer clear if prices drive production or vice versa. Therefore, this method is only robust for the time before harvesting.

A clear result of this analysis is that farmers, at least on average, do not mainly take into account previous year's planting or harvesting prices but rather consider current prices around planting time to be the more important. This is at odds with naïve and Nerlovian price expectation models, which use lagged harvest prices for estimating production decisions. Economically, it makes sense to use current prices as they include more information about the demand and supply situation than last year's prices.

Additional graphs which show the significance (p-values) of the supply response over time for all crops and both estimators are shown in the appendix (Figs. 18.4 and 18.5). For these and the subsequent graphs, model specification two was used for all crops, and only the prices were varied over time while all other explanatory variables were kept the same. As expected, these graphs show a U-shaped curve with more or less distortions depending on the crop and estimator. Figures 18.6 and 18.7 show the same results for corn while also illustrating the results for other variables: Fig. 18.6 for the difference GMM estimator and Fig. 18.7 for the system GMM estimator. These graphs again support our hypothesis that the difference GMM estimator performs better than the system GMM estimator. The fluctuations of the system GMM results were much higher, particularly for winter wheat and indica rice as shown in Fig. 18.5. Furthermore, the fluctuations of the non-price variables were also much higher, as indicated in Fig. 18.7. In general, the period up to which prices are significant extended further after planting for the difference GMM, while in the case of winter wheat the period also started before planting.

This method of investigating prices at different points in time may also be used for general model specification tests. For a robust model, we expect the significance of the tested variables to consist of low-frequency components, which implies that there are only slow and smooth changes. The occurrence of big fluctuations in a specification, in particular if some variables constantly alternate between being insignificant and significant, suggest that the specification is not robust. Figure 18.5 and in particular Fig. 18.7 accordingly indicate that the system GMM specification is less consistent than the difference GMM specification. However, the system GMM fluctuations may still be acceptable; for problematic specifications, much higher fluctuations can easily be observed. Interestingly, prices around 2–5 months before planting time seem to have such a high explanatory power in the case of the system GMM that all other variables apart from the lagged production became insignificant (Fig. 18.7). This is an indication that prices before planting might be the most important factor influencing final production. Examining the area and yield response separately could shed more light on this issue. Overall, the price response and the response to other variables were consistent with our expectations, even though many variables turned out to be insignificant.

18.5 Conclusion

The corn, winter wheat, and indica production response for the main agricultural provinces in China was analyzed using the difference GMM estimator and, for comparison, the system GMM estimator. The major findings include the following: (1) All crops strongly responded to prices at planting time. (2) The price response of corn and wheat was higher than rice. (3) While prices shortly before and after planting period had very high explanatory power, prices further away from planting period had lower coefficients and were mostly insignificant. (4) Wheat was an exception in the sense that its prices were highly significant long after planting and showed large coefficients, which could be attributed to wheat's long growing period and the crop's sensitivity 1–2 months before harvest. (5) High temperatures negatively influenced production for all crops, which may become problematic in the future due to climate change impacts. (6) Irrigation was measured poorly and therefore may have limited the significance of the results; nevertheless the results indicated that irrigation may partly help to mitigate a shortfall in rainfall but cannot (fully) compensate for the negative effects of high temperatures. (7) Fertilizer prices had a negative impact on corn production only.

In general, the difference GMM estimator seems to perform better than the system GMM estimator. The presented method to analyze the importance of prices at different points in time may also be used for general model specification tests if data on explanatory variables is available at a sufficiently high frequency.

The mixed evidence regarding the role of weather events and irrigation in affecting production could be due to the use of province-level data, which might be too aggregated to study spatially differentiated weather impacts. On the other hand, the panel data contained observations obtained over time, which is an important advantage over cross-sectional farm-level data, in particular when studying the role of determinants with little spatial dispersion (such as prices). The analysis of prices for production, one of the main contributions of this chapter, could only be undertaken with the help of a panel data set over multiple years. Not only do the findings indicate that farmers use up-to-date price information when making their production decisions, but the month-specific price elasticities also highlight when the Chinese agricultural sector can best respond to price spikes and scarcities. As the price elasticities ranged from 16 % (rice) to 34 % (wheat), increasing domestic demand can be met to a substantial extent by supply expansion – provided that prices are suitable signals about supply and demand conditions.

Acknowledgments The authors are grateful for the financial support of the Federal Ministry of Economic Cooperation and Development of Germany (BMZ) within the research project "Volatility in Commodity Markets, Trade Policy, and the Poor." The authors are also thankful for the financial support from the European Commission within the FoodSecure project and National Natural Science Foundation within research project "National Food Security Projection, Early Warning and Development Strategy" (71333013). Furthermore, the authors thank Tobias Heimann, Mahsa Shahbandeh, and Ling Zhu for collecting valuable data and providing research assistance and Mekbib Haile for very fruitful discussions on the modeling approach.

Appendix

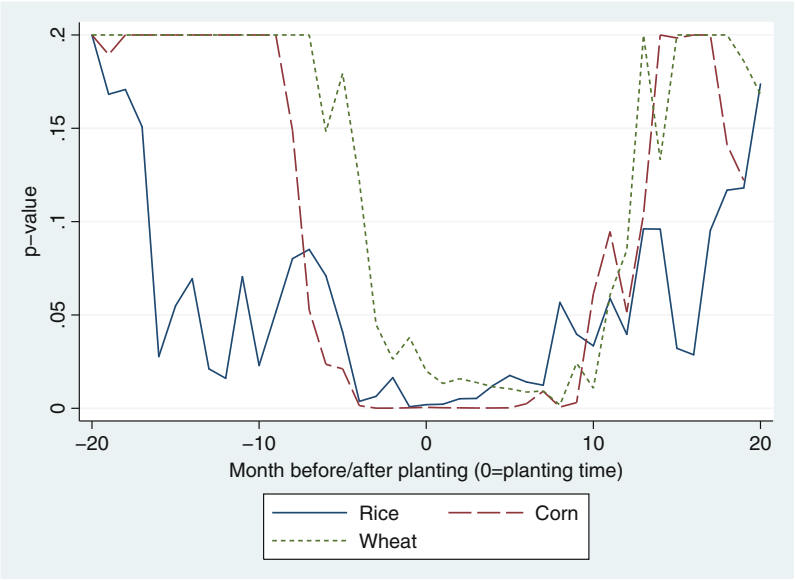

Fig. 18.4 Significance (p-value) of the wholesale prices over time for the difference GMM estimator

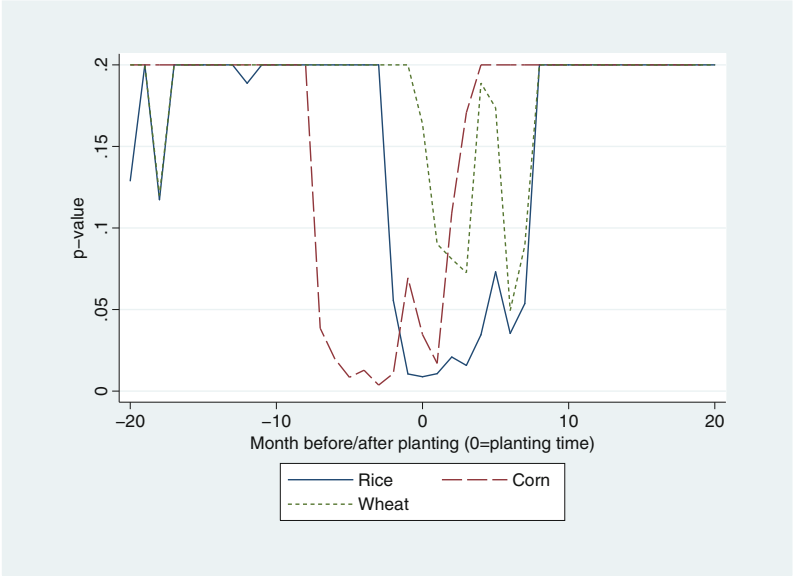

Fig. 18.5 Significance (p-value) of the wholesale prices over time for the system GMM estimator

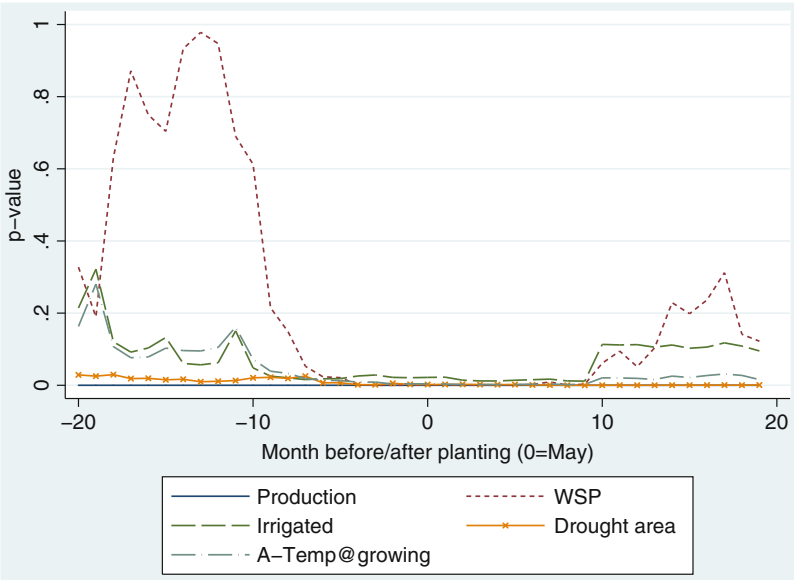

Fig. 18.6 Significance (p-value) of the explanatory variables over time for the second corn regression using the difference GMM estimator. Not all explanatory variables are shown to maintain recognizability, and the prices are the only variables which were varied over time

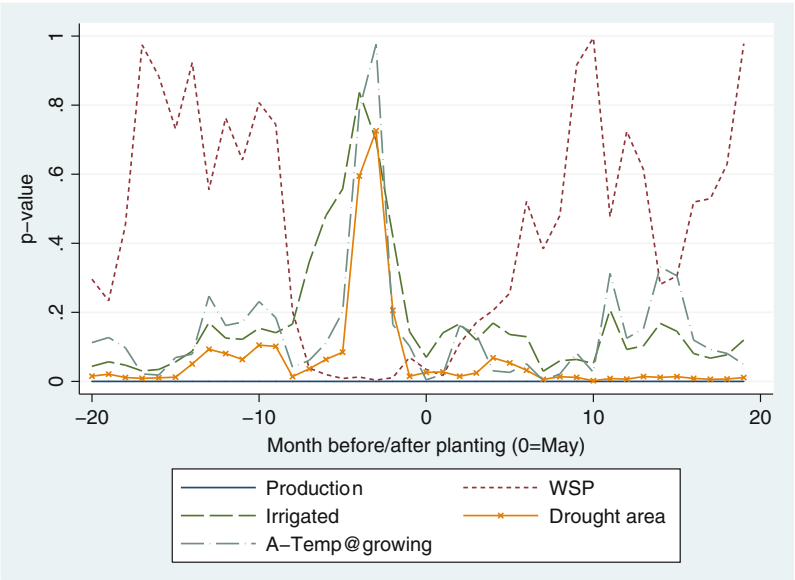

Fig. 18.7 Significance (p-value) of the explanatory variables over time for the second corn regression using the system GMM estimator. Not all explanatory variables are shown to maintain recognizability, and the prices are the only variables which were varied over time

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Consistency Between Theory and Practice in Policy Recommendations by International Organizations for Extreme Price and Extreme Volatility Situations

19

Maximo Torero

19.1 Introduction

Food prices have increased significantly in the past few years, with particularly sharp spikes seen during the 2007/08 season (see Fig. 19.1). There is some agreement on the causes of such price increases: (a) weather shocks that negatively affected agricultural production; (b) soaring energy and fertilizer costs; (c) rapidly growing income in developing countries, especially in China and India; (d) the devaluation of the dollar against most major currencies; (e) increasing demand for biofuels; and (f) changes in land use patterns. While there is no consensus on the relative importance of each of these culprits, it is widely agreed that most of these factors will further increase food prices in the medium and long run. Prices may become more volatile as well, as evidenced by the subsequent food crisis in 2010. Climate change will induce more weather variability, leading to erratic production patterns. Moreover, the volatile nature of the market is likely to induce possible speculation and exacerbating price spikes. Additionally, in an effort to shield themselves from price fluctuations, different countries may implement isolating policies, further exacerbating volatility.

Looking at the volatility at global level is important because, although the food price spikes of 2008 and 2011 did not reach the heights of the 1970s in real terms as shown in Fig. 19.2, price volatility—the amplitude of price movements over a particular period of time—has been at its highest level in the past 15 years.

High and volatile food prices are two different phenomena with distinct implications for consumers and producers as detailed in Torero (2012). Finally, increased price volatility over time can also generate larger profits for investors, drawing new players into the market for agricultural commodities. Increased price volatility

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Fig. 19.1 FAO food price index. *Source*: FAO

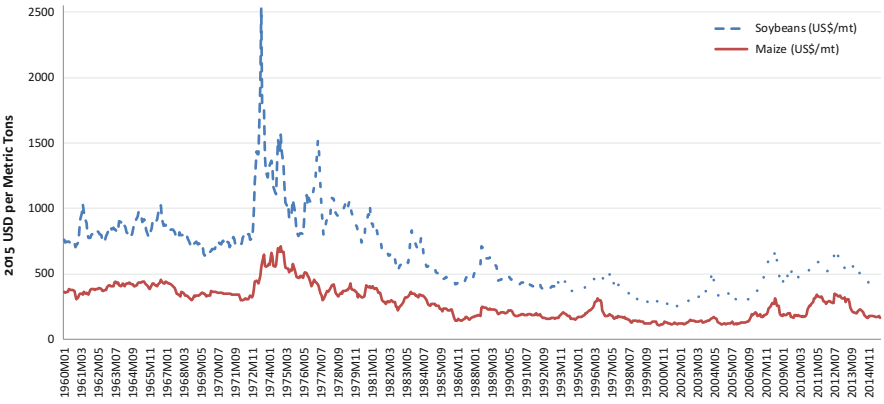

Fig. 19.2 Real price evolution. Index = 100 in 2015. *Source*: World Bank

may thus lead to increased—and potentially speculative—trading that in turn can exacerbate price swings further.

This situation imposes several challenges. In the short run, the global food supply is relatively inelastic, leading to shortages and amplifying the impact of any shock. The poorest populations are the ones hit the hardest.[1] As a large share of their

[1]There is a general concern that increasing food prices has especially adverse effects on the poor. However, until recently, there was no rigorous evidence of this. On the one hand, there would most probably be negative effects on poor urban consumers who spend a considerable portion of their budget on food. But on the other, there are gains to farmers who benefit from increased prices for their output. In general, this impact depends on whether the gains to net agricultural producers are larger than the losses to consumers. Directly dealing with this issue, Ivanic and Martin (2008)

income is already being devoted to food, the poor will likely be forced to reduce their (already low) consumption. Infants and children may suffer lifelong consequences if they experience serious nutritional deficits during their early years. Thus, the short-term priority should be to provide temporary relief for vulnerable groups.

In the long run, the goal should be to achieve food security.[2] The drivers that have increased food demand in the last few years are likely to persist (and even expand). Thus, there will be escalating pressure to meet these demand requirements. Unfortunately, increases in agricultural productivity have been relatively meager in recent years. In this line, "the average annual rate of growth of cereal yields in developing countries fell steadily from 3 % in the late 1970s to less than 1 % currently, a rate less than that of population growth and much less than the rise of the use of cereals for other things besides direct use of food" (Delgado et al. 2010, p 2).

There is a wide array of options to achieve these short- and long-term objectives, and there are no one-size-fits-all policies. Most policies come with significant trade-offs, and each government must carefully weigh the benefits and costs they would face. For example, governments might try to make food more readily available by reducing food prices through price interventions. While this policy might achieve its short-term goal, it can potentially entail fiscal deficits and discourage domestic farmers' production. Other policies not only have domestic consequences but can entail side effects for other countries. In their efforts to insulate themselves from international price fluctuations, some countries might impose trade restrictions; if a country is a large food exporter, the government might impose export taxes, quantitative restrictions, or even export bans. Albeit increasing domestic supply and lowering national prices, these policies would reduce the exported excess supply, induce even higher international prices, and hurt other nations. In addition, the "right" policies depend on the particular institutional development of a country. Middle-income countries might already have safety networks for vulnerable populations which can trigger prompt aid to those most in need in times of crisis. However, countries with lower incomes do not have such mechanisms readily available. Finally, the effectiveness of different policies will vary depending on the market characteristics of the commodity in which the government is intervening (i.e., the market structure for wheat is very different from that of rice, which is different from that of soybeans, etc.).

In this regard, this chapter describes some of the most important policies of the International Organizations like the World Bank, IFAD, AFD, and the IADB have prescribed to different countries during the food crisis of 2007/08. The

and Ivanic et al. (2011) find that the food crisis has led to significant increases in poverty rates in developing countries.

[2]Food security is a situation in which "all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs, and food preferences for an active and healthy life" (World Food Summit 1996). Even when increases in food production are not a sufficient condition for food security, they are indeed a necessary condition thereof (von Braun et al 1992).

understanding of such policies is important for at least three reasons. First, food crises are very sensitive episodes that affect the basic needs of entire populations, especially those of the world's poorest countries. As such, they require timely and sensible measures. Second, increasing food prices and price volatility are likely to remain an important challenge in the medium and long run. Third, food policies are usually complex; they need to be assessed to consider their domestic impact, the trade-offs that they entail with respect to other objectives, their consequences for other countries, and their feasibility in particular contexts.

This chapter is divided into five sections (excluding the introduction). The second section analyzes a series of policies recommended by international organizations during the 2007/08 crisis and the policies recommended at the G8 Meeting of Finance Ministers in Osaka, June 13–14, 2008. The third section analyzes the policy recommendations which came out after the 2007/08 crisis and which were the result of research work done by the same international organizations. First, some short-term policies are analyzed in which two mechanisms are emphasized: support for the poor and price stabilization (with an emphasis on trade restrictions and food reserves). Second, medium- and long-term policies to increase agricultural productivity, through productivity gains and elimination of postharvest losses, are discussed. The fourth section describes specific loans and policies prescribed for selected countries during the 2007/08 food crisis. It analyzes their consistency and cohesiveness when contrasted with the general policies that some International Organizations formally recommended as well as with those policies that were recommended after 2008. The final section summarizes and presents some concluding remarks.

19.2 Proposed Policies and the G8 Summit

In this section, a detailed description of the policies officially proposed and the G8's document prepared for the Ministers of Finance Meeting in 2008 (Table 19.1 presents a summary of all these policies) are presented. These policies can be classified either as short-term policies or as medium- and long-term policies. Specifically, within the short-term policies, we identify two groups of policies: (a) short-term support for the poorest and (b) price stabilization policies.

19.2.1 Short-Term Policies (Social Protection and Trade Policies)

19.2.1.1 Short-Term Support for the Poorest

Governments' short-term objective is to increase access to food, especially for the most vulnerable shares of their population. In this sense, policies should provide targeted short-term subsidies to those in the most distress. Countries that already have Targeted Cash Transfer (TCT) and Conditional Cash Transfer (CCT) programs in place can scale them up and increase the subsidies they provide (World Bank 2008). TCTs provide additional income to poor households with children or disabled or elderly members. CCTs provide the same benefits but are contingent on some

Table 19.1 Policies proposed by International Organizations and G8 Summit

	Proposed policies under the Global Food Crisis Response Program (GFRP)	G8's "Addressing the food crisis"[a]
Trade policy		
Tariff and VAT reductions	– "At first glance, reducing tariffs and other taxes on key staples is both effective and desirable. In times of sharply increasing prices, reductions in tariffs and taxes can provide some relief to consumers, albeit at a fiscal cost . . . Yet longer term, such unilateral changes in one tariff but not others may alter the structure of relative incentives and could end up channeling private resources to second-best uses in terms of growth and welfare, which illustrates the need to consider separately short and longer term responses" (pgph. 13)	– Recommended for all countries with significant taxes and tariffs on food grains: – Can significantly lower domestic prices in countries where share of tariffs in retail prices is high but scope limited in low tariff settings – Easy to implement – Domestic food grain producers face more competition – Fiscal losses depend on composition of domestic revenues
Export bans and restrictions	– "The least desirable trade-related policy interventions to manage food prices are export restrictions or bans on key staples . . . This type of measure has a limited impact on domestic price levels and a significant negative effect on the earnings of domestic producers and exporters. Besides leading to sharp price fluctuations and supply uncertainty in countries that depend on imports, these measures often have the greatest negative impact on the country imposing the restriction as domestic production and foreign exchange earnings fall and traditional commercial relationships are severed" (pgph. 14)	– Bad policy option in all countries due to negative externalities on others and disincentives for future production – Can help stabilize domestic grain prices in the short run but undermines long-term supply response – Creates disincentives for domestic producers particularly those dependent on export markets – Serious beggar-thy-neighbor effects due to price volatility and shortages particularly when they are applied by major exporters
Promotion of bilateral or regional trade	– "Finance technical assistance and investments for regional trade and transport facilitation. It could also finance activities that would accelerate on-going trade facilitation actions that would specifically improve the functioning of regional staple food and input markets. Assessments of technical, policy, logistical and other constraints to regional and cross-border trade in staple foods and agricultural inputs will be supported" (pgph. 100, B6)	

(continued)

Table 19.1 (continued)

	Proposed policies under the Global Food Crisis Response Program (GFRP)	G8's "Addressing the food crisis"[a]
Food reserves		
Use of strategic grain reserves (buffer stocks) to lower prices	– "Many countries maintain physical grain reserves in lesser or greater volumes. These reserves are maintained in order to service emergency relief operations, support public distribution of food to chronically food insecure populations, and reduce volatility in consumer and/or producer prices. International experience in the management and use of so-called strategic grain reserves[b] is mixed, with frequent concerns about operational inefficiencies, financial cost, and disincentives for private traders to perform normal arbitrage functions. Some of the problems with grain reserves can be overcome by establishing clear and open rules for market interventions, including the private sector in the tendering for supplies for the reserves, combining grain and financial reserves to reduce costs, and utilizing very professional management, supported by good information systems and analytical capacity" (Annex 5, pgph. 27)– GFRP provides technical assistance for grain stock risk management (Annex 5, pgph. 28)	– Second best option used in low-/middle-income countries which have the capacity to manage food stocks and need to respond quickly to food availability issues (they insure against delays and price volatility in international markets) – Can be used to provide targeted consumer subsidies – Excess stocks can undermine private markets and reduce capacity to respond during shocks – Professional management of stocks with good management information systems and clear criteria for market intervention required
Use of strategic grain reserves for humanitarian purposes	– "About one-fifth of developing countries sampled have begun adding to grain buffer stocks, creating, re-creating, or adding to 'strategic reserves'. These are often used to provide subsidized food rations for the poor. Recent price spikes in international markets, and the current difficulty in obtaining supplies, particularly in the rice market, suggests that more countries will try to increase domestic stockholdings despite the high costs of management and risks of leakage. If so, this is likely to perpetuate the price spike as participants go into global markets with higher orders than normal despite the much higher prices. An alternative approach using financial instruments rather than physical grain stores is for governments to enter into contingency purchasing contracts with domestic and/or international suppliers" (pgph. 15)	

Social protection		
Cash transfers (means-based and CCTs)	– "Direct transfers in cash or in kind, are the simplest and most straightforward way to get additional resources to the most vulnerable households to mitigate the effects of a food crisis. Targeted Cash Transfers (TCTs) are preferable to in-kind transfers, as they avoid incurring the costs of food transport and distribution. They often target households with children, elderly or disabled individuals. These programs have relatively low administrative costs and do not distort prices. Benefits can be differentiated by level of need, household size or composition. Similarly, existing Conditional Cash Transfer Programs (CCTs) (which link the benefit to requirements such as school attendance or health service take-up) are an option for channeling support rapidly—but the complexity of such programs means it will not normally be feasible to establish new ones as vehicles for an emergency response" (pgph. 110) – "Cash programs are preferred to in-kind programs, as they have lower administrative costs. However, when local food markets do not function and food is not available, in-kind programs are preferred" (Annex 5, pgph. 47)	– Best suited to countries with sufficient institutional capacity to appropriately target and disburse cash to large numbers of people (middle income and selected low income) – Typically cash transfers have lower overhead costs relative to food programs – Can be linked to use of health and education services (conditional cash transfers). Where access to health and education services is limited, the condition may rule out the neediest families. Moreover, monitoring the compliance with conditions involves an extra administrative system. Where programs are well established, their benefit can be raised or their coverage expanded, but setting up new programs has a long lead time. Unconditional needs based cash transfers more broadly applicable during crises – Transfer amounts need to be adjusted to keep pace with inflation

(continued)

Table 19.1 (continued)

	Proposed policies under the Global Food Crisis Response Program (GFRP)	G8's "Addressing the food crisis"[a]
Near cash transfers (food stamps, vouchers, etc.)	– "Food stamps are an intermediate step between cash transfers and food distribution. GFRP may support the subsidy value of food stamps and the associated logistics (e.g., printing physical food stamps or supplying smart cards). It will fund the analysis of needs and targeting criteria; program monitoring; the development of necessary infrastructure; and financing for new programs/scaling up existing food stamp and food ration programs, including means for stamp redemption and for smart cards to reduce leakage" (pgph. 111)	– Most often used when countries are transitioning from in-kind to cash transfers – Lower overheads than food transfers, slightly higher than for cash transfers – Requires retail chain and effective distribution system
Public work programs	– "Labor intensive public works programs are an option to generate incomes in targeted communities while also delivering services, rehabilitation or construction of infrastructure. These programs are particularly useful in the absence of good household targeting systems as they self-select unemployed beneficiaries by requiring them to work. So long as wages are set below market levels they are not likely to displace people from existing jobs" (pgph. 114)	– Recommended for low-income countries where targeting cash transfers via means or proxy means testing is difficult – Potential for effective self-targeting, though often scale of program is small enough that additional targeting criteria are needed – Local infrastructure can be created but quality control important – Effective implementation of the work programs is administratively demanding – Substantial nonlabor costs (usually 40–60 % of total) – Administrative costs of handling food higher than comparable cash for work programs

Feeding programs (school-based and maternal/child feeding)	– "In countries where no large cash transfer system is in place, they (school feeding) may offer the best option for delivering additional resources quickly and on a large scale, to offset the impact on household budgets of the food crisis. Like CCTs, they have the additional benefit that they act as an incentive to send children to school and thus, they lower the probability that children will be taken out of school in response to the negative income effect of food price rises (e.g., to send them to work). As well as food consumed at school, take-home rations could be distributed for consumption by younger siblings. Geographical targeting could be used to focus on the poorest areas of the country" (pgph. 113) – "GFRP will provide short-term support to strengthen the coverage and delivery of existing nutrition and primary health programs. Priority areas for support will include (a) Nutrition education and growth promotion to improve nutritional practices by changing behaviors with respect to breastfeeding and complementary infant feeding, dietary quality, hygiene, and child care. (b) Provision of targeted food supplements and micronutrients, including (i) food supplements for vulnerable pregnant and lactating women and children under 2 years, for recuperation of severely malnourished children, and for HIV/AIDS patients under treatment with antiretroviral drugs, (ii) micronutrients such as iron and folic acid supplements, Vitamin A, and interventions to address iodine and zinc deficiencies for high-risk population, (c) Other primary health interventions which reduce the risk of malnutrition (such as immunizations, oral re-hydration therapies and protection against malaria) could also be supported" (pgph. 116)	– Recommended for countries in parallel with above options as the primary focus of these programs is on protecting the most vulnerable—e.g., children and mothers – Maternal feeding can encourage accessing other health/nutrition education services – School feeding can be combined with other interventions such as deworming – Food needs to be low cost yet nutritious and feeding timed to minimize teaching disruptions—take-home rations are an alternative to on-site feeding – While school feeding can effectively target children, it misses infants whose feeding needs are highest – Nutritional supplementation programs may need to be scaled up, especially for infants

(continued)

Table 19.1 (continued)

	Proposed policies under the Global Food Crisis Response Program (GFRP)	G8's "Addressing the food crisis"[a]
Strengthening social protection programs	– "GRFP will finance capacity building and related investments needed to develop new programs and to improve program effectiveness of existing programs. This may include activities to (a) recommend and implement appropriate developments of the social protection system to provide a basis for more effective mitigation to future crises; (b) improve the capacity of existing transfer programs in selection of beneficiaries (targeting and needs analysis); beneficiary registers; payment systems for cash transfer programs and delivery systems for in-kind programs; procurement systems; program governance; oversight mechanisms aimed to reduce the amount of funds lost to error, fraud or corruption; Management Information Systems (MIS), monitoring and evaluation; communication campaigns; (c) strengthen linkages between the transfer programs and the health and education sectors, for example, ways to verify compliance with conditionality; (d) to strengthen communication on health and nutrition and (e) the monitoring and evaluation of social protection, health and nutrition programs" (pgph.118)	
Food subsidies	– "Food subsidies via untargeted open market sales, subsidies on imports, ration shop sales and other measures to lower the market price for consumers can entail a substantial fiscal cost. Subsidy costs can be reduced by taking into consideration (i) type of food commodity to be subsidized, (ii) mechanisms to reduce leakages, and (iii) exit strategies" (Annex 5, pgph. 26)	– Second best option in countries where targeted safety net programs cannot be scaled up sufficiently during crises – May not distort domestic markets much if consumer subsidy is financed by the budget and not by limiting producer prices; is rationed; and is applied to products consumed mainly by the poor (e.g., coarse rice) – Institutional ability to operate "low price markets/shops" with adequate food rations is required – There is some risk of the rich hiring the poor to procure subsidized items

Price controls on strategic staples or on trader margins		– Bad policy option in all countries – Lowers prices to all consumers regardless of need – Discourages domestic production, processing, and trade – Creates black markets and rationing which often benefit more affluent people – Danger of aggravating rapid migration to cities over time
Other price stabilization policies	– "To avoid major fiscal deficits that could threaten macro-stability or cuts in public expenditures that could threaten development, governments may request funding under this facility to finance short-term price stabilization programs, including market intervention policies such as open-market sales of stocks or imports" (Annex 5, pgph. 15)	
Supply policies		
Higher levels of public and private investment in agricultural support services	– GFRP "provides technical and financial assistance to support governments in their immediate and medium-term response to the crisis resulting from shortfalls in domestic food availability in combination with rising international food prices" (pgph. 71) – "Longer-term lending to support investments in infrastructure will continue using regular Bank mechanisms, and support under GFRP would not displace longer-term agriculture-related lending such as investments in irrigation infrastructure, rural roads or agriculture research" (Executive Summary, pgph. 7) – GFRP does support the following policies: • Rehabilitation of existing small-scale irrigation • Strengthening farmer access to critical information (dissemination of technology, advisory services, linking farmers to markets, ICT applications, etc.).	– Necessary investment in all regions – Significant scope for increasing yields in all regions through greater use of existing technology and water and soil management – Agricultural research as share of agricultural output lags behind in LDCs relative to MICs—essential for continued productivity increase – Revamped extension with product marketing services required—investments in data, capacity, and community-based extension important – Public investments need to ensure sufficient provision for operations and maintenance (e.g., large irrigation projects) – Agricultural strategies need to differentiate between needs of commercial farmers and those of smallholders

(continued)

Table 19.1 (continued)

	Proposed policies under the Global Food Crisis Response Program (GFRP)	G8's "Addressing the food crisis"[a]
Reduction of postharvest losses	– "Support could take various forms, including: (i) training and demonstration of low cost on-farm storage technologies; (ii) technical assistance, training and investment support for community-level 'food banks'; (iii) training and facilitation of investment by grain traders and millers in drying, sorting, and fumigation equipment and upgrades in existing storage facilities; (iv) rehabilitation of rural roads and bridges where deficiencies in such transport infrastructure are shown to substantially contribute to staple food product/quality losses; and (v) training, technical assistance, and supplemental equipment to strengthen existing food grain quality control inspectorate services and food safety surveillance systems" (pgph. 123)	– Necessary investment in all regions – Reduction of postharvest losses (estimated up to 25 % of output) is key to greater intensification of production
Investment in rural and trade-related infrastructure	– GFRP does not provide support for rural roads. Roads would be financed through regular Bank mechanisms	– Priority in countries with poor trade and transport infrastructure, in rural areas – Improvements in rural accessibility can lead to lower prices of all products as well as stimulate surplus production – Investments in improving customs, logistics management, and marketing infrastructure will strengthen producer incentives
Input subsidies	– "Provide finance and technical assistance: (i) to reform laws and regulations which inhibit the development of agricultural input markets; (ii) to develop or scale up voucher and supplier credit schemes, based on 'smart subsidy' and other principles; (iii) for investments and training to strengthen existing systems for seed and fertilizer quality control; (iv) for investments to upgrade/rehabilitate seed multiplication and distribution facilities, and (v) for fertilizer imports through revolving fund or other financially sound mechanisms" (pgph. 72)	– Appropriate for low-income countries where access by farmers to credit, farming inputs, and risk management instruments is limited – Fiscal costs can be high – Subsidies need to be transparent and well targeted – Exit strategy needs to be built-in and communicated publicly – Risks crowding out private input supply

Strengthening access to finance and risk management tools	– "Support: (i) credit lines and capacity-building for formal financial institutions to increase agricultural lending; (ii) the development of legal/regulatory frameworks and provision of credit lines and technical assistance to extend the use of supply chain finance; (iii) the scaling up of community-based financial institutions; (iv) feasibility studies and training to enable farmer organizations, market intermediaries, and financial institutions to utilize selected physical or financial strategies to manage commodity price risks; and (v) feasibility studies, training, and advisory services to facilitate further applications of commercial agricultural (and weather) insurance" (pgph. 125)	– Appropriate for all countries particularly those susceptible to large fluctuations in agricultural output – Support required for innovative financing mechanisms for supply chain management and managing commodity price volatility – Financial products which transfer weather-related risks to international insurance/derivative markets are complex and required capacity building and possibly government cost-sharing
Other policies		
Price risk management	– "Provide support to governments and major private sector entities to identify if/how market-based hedging products can be incorporated in national policies and commercial strategies, and, where feasible, to implement price hedging transactions" (Annex 5, pgph. 29)	– (Forward contracts for international grain procurement are) Appropriate for countries with data/capacity required to make decisions on forward contracts – Government role is to facilitate implementation in the public interest by private sector entities rather than function as direct market actors

(continued)

Table 19.1 (continued)

	Proposed policies under the Global Food Crisis Response Program (GFRP)	G8's "Addressing the food crisis"[a]
Early warning and weather risk management for food crop production	– "The following activities are included: (i) investment in automatic weather station infrastructure and data reporting systems; (ii) capacity building in agro-meteorology, crop surveillance, and crop estimation systems; (iii) assessment of the technical, operational, and commercial feasibility of applying weather-indexed insurance or derivative products as part of disaster risk management strategies; (iv) technical assistance in insurance product design, (v) intermediation services for weather risk management transactions between client governments and the international market; (vi) partial financing of premiums on weather insurance/derivative transactions and (vii) technical support to help governments develop plans for utilizing funds that accrue from insurance payouts, for example, in designing safety net programs that scale up on the basis of payments" (pgph. 100, B5)	

[a]Taken from World Bank (2008) Addressing the food crisis: the need for rapid and coordinated action. Group of Eight, Meeting of Finance Ministers. Osaka, June 13–14, 2008. Annex 4

[b]Throughout the GRFP Framework document, the definition of "Strategic Reserves" is unclear. In some sections, they seem to refer to humanitarian reserves (whose purpose is food distribution among the poorest), while in others they seem to reflect (generalized) price stabilization objectives

conditionality (which usually encompasses an educational, nutritional, or health requirement). These approaches of cash transfer constitute first-best responses for several reasons: (a) they prioritize assistance for targeted groups, (b) they do not entail additional costs of food storage and transportation, (c) they do not distort food markets, and (d) in the case of CCTs, they explicitly prevent human capital deterioration. However, there is an important shortcoming to these approaches: countries with weaker administrative capacity—which are usually those most affected by food crises—are less likely to have implemented any TCTs or CCTs.[3] In this line, Delgado et al. (2010) argue that "it is essential that during noncrisis years, countries invest in strengthening existing programs—and piloting new ones—to address chronic poverty, achieve food security and human development goals, and be ready to respond to shocks."

When TCTs and CCTs are not available, governments may implement other types of assistance programs. First, school feeding (SF) programs might be useful to relieve child malnourishment. However, they are usually ineffective to combat infant malnutrition (when adequate nutrition is most needed), unless food consumed at school can be complemented with take-home rations for younger siblings. Additionally, SF relies on geographic rather than household-specific targeting and entails food storage and distributions costs. Food for Work (FfW) programs are a second option. These are easier to implement and are (in principle) self-targeted: they provide low wages so only poor people should be interested in participating. However, in very poor regions, the vast amount of unemployed and underemployed may lead to considerable leakages and distortions in the labor market (Wodon and Zaman 2008). Also, only a portion of the funds allocated to these programs directly cuts poverty. Beneficiaries leave other jobs to participate in them; thus, the benefits of FfW are not the whole wages they provide, but only the differential income (with respect to the previous job). These programs might create distortions in the labor market. Finally, governments can also provide direct food aid. However, there is no guarantee that this aid can be effectively targeted toward the most vulnerable populations. Furthermore, food aid may become an entitlement and might result in long-term fiscal problems.

19.2.1.2 Price Stabilization Policies

Support programs for the poorest might not be easily implemented during food emergencies because they take time to be put into action. At the very least, they require a distribution network and plenty of logistical coordination. This forces governments to implement other policies to shield their population from food emergencies. Moreover, even when technically sound schemes such as CCTs are readily available during a crisis, some countries might still try to pursue more widespread

[3]For example, these policies might be more suitable for medium-income countries, such as in Latin America. World Bank—LAC (2008, Table 8) documents 17 countries with CCTs and 18 countries with Targeted Nutritional or Social Assistance Programs.

measures for political reasons.[4] Constituencies (and, in general, populations) are very sensitive to food prices, and governments may fear opposition, turmoil, or even being ousted. For example, Burkina Faso suspended import taxes on four commodities after the country experienced riots over food prices in February 2008. Other countries that experienced riots during the 2007/08 crisis were Bangladesh, Cambodia, Cameroon, Côte d'Ivoire, Egypt, Indonesia, Mauritania, Senegal, and Yemen (Demeke et al. 2008).

In this light, many countries try to stabilize prices through trade policies and management of food reserves. The specific trade-offs imposed by these mechanisms will be discussed subsequently. In general, they are not first-best options: countries use scarce resources to reduce general prices, effectively subsidizing both the poor and the nonpoor[5] and creating potentially pervasive market distortions. However, countries with no other means or with politically unstable regimes may have few other options to cope with food emergencies.

19.2.2 Medium- and Long-Term Policies

Short-term responses mainly deal with demand problems as consumers—and especially the poor—are hard-hit. However, short-term policies that help consumers might be detrimental for producers and for market development in the long run. For example, export taxes on wheat in Argentina help decrease consumer prices, but also disincentive production. As suggested by a newspaper article, "with scant incentive to produce, farmers have slashed the land sown with wheat to a 111-year low, and cereal exports from the rolling pampas of what should be a breadbasket country have virtually halved over the past 5 years. Wheat farmers in Argentina have turned to other crops, such as soybean, while some international investors, who are critical to the flow of money into capital-intensive agriculture, have left the country and turned to Uruguay, Paraguay, and Brazil".[6] While acknowledging the importance of short-term responses to food crises, these responses should be chosen to minimize any long-term adverse effects on agricultural supply.

[4] As suggested by HDN and PREM (2008), "effective nutritional and social protection interventions can protect the most vulnerable from the devastating consequences of nutritional deprivation, asset depletion and reductions in education and health spending. Policy responses need to balance political economy considerations that call for measures to help a broad swath of the affected population, with the urgency of protecting the very poor."

[5] Wodon and Zaman (2008) posit the following argument: "Consider the share of rice consumption in the bottom 40% of the population. This share varies from 11% in Mali to 32% in Sierra Leone. This means that if one considers the bottom 40% as the poor, out of every dollar spent by a government for reducing indirect taxes on rice, and assuming that the indirect tax cuts result in a proportionate reduction in consumer prices, only about 20 cents will benefit the poor on average."

[6] "Argentina's farmers unable to fill the wheat gap," Financial Times, August 10th, 2007. Link: http://www.ft.com/intl/cms/s/0/910f25ac-a4a8-11df-8c9f-00144feabdc0.html#axzz1vXMMOjP5

Long-term policies that expand food availability are becoming increasingly important.[7] Agricultural demand has experienced large expansions in recent years—even above that regularly imposed by population growth—due to rapidly growing incomes in developing countries (such as China and India) and rising demand of food for biofuel production in developed countries.[8] As these patterns are likely to persist, there is a need to increase agricultural supply in order to keep up with the additional demand.[9]

There are two main policies targeted toward increasing food production. The rate of growth of the yields of major crops has been declining steadily since the 1970s. Thus, on the one hand, there is the need to enhance the productivity and resilience of major crops. Yet many challenges will make this a daunting task. Availability of fertile land will be limited by increasing urbanization, salinization, erosion, and degradation. Water will also become scarcer. Additionally, climate change will most certainly have an adverse effect on agricultural production through erratic rainfall, pest proliferation, and crop failure. Thus, any policy to increase agricultural productivity should address these complex obstacles.

On the other hand, supply can also be expanded through the enhancement of postharvest practices. Between harvest and consumers' access to food, agricultural production goes through many stages: product processing, storage, handling, transportation, and distribution. In each of these phases, there are production losses. For example, grains molder with improper storage technologies and facilities, as well as poor roads, preventing food from reaching markets. Albeit complementary, even in the absence of productivity gains, better postharvest practices can have a significant impact on food availability.

19.3 Policies Recommended After 2008

19.3.1 Short-Term Policies

19.3.1.1 Trade Policies

When faced with increasing food prices, net food exporters can impose export taxes or bans. While lower prices hurt local producers, these policies do benefit

[7] Examples of other policies in the long run are: production and price insurance for farmers; provision of other public goods for rural areas (such as education and health services); policies for water basin management; technology improvements for rainfed land (water capture infrastructure, practices for water retention in soil, etc.); strengthening of producer organizations; etc. Certainly, these are also important policies. However, for the sake of brevity, they are not mentioned here.

[8] Mitchell (2008) estimates that about 70–75 % of food price increases were due to rising food demand for biofuel production.

[9] As suggested by the World Bank's South Asia Region report (2010), "the food crisis is by no means over… There is growing agreement that a two-track approach is required, combining investments in safety nets with measures to stimulate broad-based agricultural productivity growth, with major emphasis on major food staples."

domestic consumers and boost the revenue of governments enacting them. Thus, it is not surprising that many food-producing countries enacted some form of export restriction during the 2007/08 food crisis. Demeke et al. (2008) surveyed different government policies in 81 developing countries and found that 25 of them either banned exports completely or increased export taxes.

Analogously, net food importers can decrease their tariffs (or even subsidize imports) to buffer the impact of rising international food prices. At least in the short run, these policies are able to temporarily reduce internal prices; however, they also have domestic side effects (see Table 19.1). Some argue that tariff reductions might not have been effective in shielding importing countries from the 2007/08 food crisis. FAO et al. (2011) argue that "the scale of price increases was such that for many countries reducing import tariffs had relatively modest impact because the initial tariffs were low or the scale of the price increases was so large. In any event, this instrument was quickly exhausted as tariffs were reduced to zero" (p. 14). Additionally, tariff reductions diminish governments' revenue, leaving them with fewer resources with which to palliate the impact of food price increases. The situation might be especially serious when there are few alternative sources of revenue (e.g., weak tax collection, large informal sector, etc.). Eventually, this could lead to serious fiscal deficits.

These strategies should not entail any consequences for international markets if only small countries implement them. These countries' food exports or imports are not substantial relative to international trade, and they are mostly price takers on the world markets. However, trade policies of large food exporters or importers do effectively affect international supply or demand of a commodity. When large exporters impose export restrictions during a food emergency, they tighten the already short supply abroad and further increase international prices. In a similar fashion, as large food importers reduce their tariffs, they increase internal consumption, fueling global demand and generating further escalations of food prices in external markets. If exporting and importing countries both follow these strategies, their efforts to insulate themselves might cancel out each other's efforts.

Martin and Anderson (2011) describe this phenomenon on the international market for a certain commodity. Initially, there is excess supply from world's exporters and excess demand from importers. The authors then consider an exogenous shock that reduces production in some exporting countries. In the absence of any trade policy, this shock changes the balance between supply and demand. If a large exporting country tries to avoid an increase in domestic prices and imposes a tax on exports, this further reduces the excess supply and leads to higher international prices. If a large importing country retaliates and reduces its tariffs to exactly offset the trade policy imposed by the large exporter, this would increase global excess demand. The final outcome in this scenario is that the traded quantity and price in both countries would be the same as before either policy was enacted. However, other countries around the world would be worse off, as the final price on the international market would soar. This can eventually give other countries the incentive to impose similar policies, leading to a trade war of import tariffs and export taxes. As Martin and Anderson (2011) suggest, "insulation generates a

classic collective-action problem akin to when a crowd stands up in a stadium: no one gets a better view by standing, but any that remain seated gets a worse view."

So to what extent should countries implement such policies and impose beggar-thy-neighbor consequences upon others? There is no consensus in this respect. On one hand, Timmer (2010) analyzes the implications of trade restrictions on rice markets during the 2007/08 food crisis and finds that stabilizing domestic prices using domestic border intervention could be an effective strategy to handle food crises. Timmer argues that unstable demand and supply needs to be accommodated somehow, and that passing this responsibility to the international market may be the most fair and successful way to do so.

On the other hand, Anderson and Nelgen (2012) advise against any trade restrictions, using a model of supply and demand for the market of a particular commodity. Their results are presented in Tables 19.2 and 19.3. Table 19.2, not surprisingly, shows that trade restrictions did boost international food price increases between 2006 and 2008.[10] Yet the results also suggest that everyone should take part of the blame for this: the policies of both exporting and importing countries, and both developing and high-income countries, fueled the price increases. Table 19.3 compares the changes in international prices that would have taken place without trade interventions with effective domestic prices. All in all, their estimates show that these policies had a very heterogeneous impact for different countries and commodities. On average for all countries, domestic wheat prices increased more than adjusted international prices. These policies were somewhat more effective for other crops, but overall their effect was not large: 2 % for maize and 12 % for rice.

Anderson and Nelgen (2012) advise governments to refrain from imposing insulating trade policies because they amplify price increases and, moreover, are not always effective. Theoretically, small countries cannot affect international markets individually by changing their trade policies. However, Anderson and Nelgen (2012) claim that if many small countries do so simultaneously, it can have an aggregate

Table 19.2 Contributions of high-income and developing countries, and of importing and exporting countries, to the proportion of the international price change that is due to policy-induced trade barrier changes, 2006–08[a]

	Total proportional contribution	High-income countries' contribution	Developing countries' contribution	Importing countries' contribution	Exporting countries' contribution
Rice	0.40	0.02	0.38	0.18	0.22
Wheat	0.19	0.09	0.10	0.07	0.12
Maize	0.10	0.05	0.05	0.03	0.07

[a]Taken from Anderson and Nelgen (2012), Table 7

[10]Their findings are qualitatively consistent with those of Bouët and Laborde (2010). Their calculations are based on a multicountry general equilibrium model for wheat. They show how price increases are amplified by both tariffs and export taxes.

Table 19.3 Comparison of the domestic price with the rise in international grain prices net of the contribution of changed trade restrictions; rice, wheat, and maize, 2006–2008 (% unweighted averages)[a]

	International price rise		Domestic price rise		
	Incl. contribution of changed trade restrictions	Net of contribution of changed trade restrictions	All countries	Developing countries	High-income countries
Rice	113	68	56	48	74
Wheat	70	56	77	65	81
Maize	83	75	73	62	82

[a]Taken from Anderson and Nelgen (2012), Table 8

sizeable impact. In this line, they argue that trade restrictions and reduction of import tariffs should be discouraged across the board.

To analyze this last point, Table 19.4 shows the shares of imports and exports for soybean, rice, wheat, and maize by region (following the World Bank classification)[11] in 2004, before the food crisis. We posit that Anderson and Nelgen's results (in Tables 19.2 and 19.3) seem to hide very large disparities within their "exporting," "importing," "developing," and "high-income" labels. For example, estimates in Table 19.2 show the impact of trade restrictions on the increase of the international price of rice to be around 40 %; 38 % is from developing (with the remaining 2 % from high-income countries) and 18 % is from importing countries (and the remaining 22 % from exporting countries). From the export side, Thailand, India, and Vietnam—which account for 65 % of all rice exports—imposed trade restrictions. From the import side, important importers such as the Philippines and other Asian countries were concerned about a potential shortage and reduced their tariffs. Policies enacted by these large players exemplify how trade restrictions can lead to significant price spikes. However, from the evidence presented in Tables 19.2 and 19.3, it is unclear if trade restrictions by smaller countries would entail serious consequences for international markets. For example, Sub-Saharan Africa accounts for 0.1 % of rice exports worldwide. Excluding Nigeria, South Africa, Côte d'Ivoire, and Ghana, the share of all other Sub-Saharan African countries was only 10.7 % of worldwide rice imports. It is reasonable to believe that, even if all nations in this region changed their trade policies, there would not be a sizable impact on the international rice market.

While economists tend to be more critical of the use of import barriers as creating instability in world markets, they frequently applaud import barrier reductions undertaken in the same context. There may be some basis for this support if the reduction is believed to be permanent once undertaken. If, however, it is undertaken purely on a temporary basis as a way to reduce the instability of domestic prices, the effects on the instability of world prices are clearly quite symmetric. From a policy

[11] See http://data.worldbank.org/about/country-classifications/country-and-lending-groups

Table 19.4 Share of exports and imports by region and selected countries for soybeans, maize, wheat, and rice (2004)

1.A: Soybean exports, 2004		
	Exports (US$, thousands)	Share (%)
High income	7,563,204	48.5
United States of America	6,692,040	42.9
All others	871,164	5.6
East Asia & Pacific	161,858	1.0
Europe & Central Asia	17,518	0.1
Latin America & Caribbean	7,827,815	50.2
Brazil	5,394,910	34.6
Argentina	1,740,110	11.2
All others	692,795	4.4
Middle East & North Africa	315	0.0
South Asia	897	0.0
Sub-Saharan Africa	7144	0.0
Others	5101	0.0
Total	15,583,852	100.0
1.B: Soybean imports, 2004		
	Imports (US$, thousands)	Share (%)
High income	8,035,760	41.0
Japan	1,774,620	9.1
Netherlands	1,504,200	7.7
Germany	1,129,570	5.8
All others	3,627,370	18.5
East Asia & Pacific	8,935,462	45.6
China	7,680,418	39.2
All others	1,255,044	6.4
Europe & Central Asia	252,591	1.3
Latin America & Caribbean	1,693,014	8.6
Mexico	1,107,990	5.7
All others	585,024	3.0
Middle East & North Africa	605,239	3.1
South Asia	36,913	0.2
Sub-Saharan Africa	10,572	0.1
Others	14,763	0.1
Total	19,584,314	100.0

(continued)

Table 19.4 (continued)

2.A: Rice (milled) exports, 2004		
	Exports (US$, thousands)	Share (%)
High income	1,324,307	18.0
East Asia & Pacific	3,534,287	47.9
Thailand	2,368,150	32.1
Vietnam	950,315	12.9
All others	215,822	2.9
Europe & Central Asia	18,692	0.3
Latin America & Caribbean	174,862	2.4
Middle East & North Africa	227,739	3.1
South Asia	2,076,696	28.2
India	1,448,460	19.6
Pakistan	627,240	8.5
All others	996	0.0
Sub-Saharan Africa	9500	0.1
Others	5479	0.1
Total	7,371,562	100.0
2.B: Rice (milled) imports, 2004		
	Imports (US$, thousands)	Share (%)
High income	2,341,903	35.1
Saudi Arabia	534,327	8.0
United Arab Emirates	327,843	4.9
United States of America	257,666	3.9
All others	1,222,067	18.3
East Asia & Pacific	1,045,859	15.7
Philippines	274,585	4.1
China	268,003	4.0
All others	503,271	7.5
Europe & Central Asia	187,705	2.8
Latin America & Caribbean	408,097	6.1
Middle East & North Africa	713,678	10.7
Iran	294,853	4.4
Iraq	173,481	2.6
All others	245,344	3.7
South Asia	320,804	4.8
Sub-Saharan Africa	1,488,627	22.3
Nigeria	297,000	4.4
South Africa	202,605	3.0
Côte d'Ivoire	166,656	2.5
Ghana	108,412	1.6
All others	713,954	10.7
Others	170,998	2.6
Total	6,677,671	100.0

(continued)

Table 19.4 (continued)

3.A: Wheat exports, 2004		
	Exports (US$, thousands)	Share (%)
High income	15,522,857	80.4
United States	5,180,990	26.8
Australia	3,089,040	16.0
Canada	2,688,820	13.9
France	2,553,110	13.2
All others	2,010,897	10.4
East Asia & Pacific	116,505	0.6
Europe & Central Asia	1,463,350	7.6
Russian Federation	535,975	2.8
Kazakhstan	389,550	2.0
Ukraine	288,900	1.5
All others	248,925	1.3
Latin America & Caribbean	1,663,311	8.6
Argentina	1,365,480	7.1
All others	297,831	1.5
Middle East & North Africa	161,885	0.8
South Asia	328,790	1.7
Sub-Saharan Africa	49,506	0.3
Others	30	0.0
Total	19,306,234	100.0
3.B: Wheat imports, 2004		
	Imports (US$, thousands)	Share (%)
High income	7,160,391	33.0
East Asia & Pacific	3,905,051	18.0
China	1,873,488	8.6
Indonesia	841,000	3.9
Rest	1,190,563	5.5
Europe & Central Asia	1,437,367	6.6
Latin America & Caribbean	2,864,681	13.2
Brazil	838,770	3.9
Mexico	617,765	2.8
Rest	1,408,146	6.5
Middle East & North Africa	3,644,814	16.8
South Asia	553,803	2.6
Sub-Saharan Africa	2,081,078	9.6
Nigeria	475,983	2.2
Sudan	209,055	1.0
Rest	1,396,040	6.4
Others	32,260	0.1
Total	21,679,445	100.0

(continued)

Table 19.4 (continued)

4.A: Maize exports, 2004		
	Exports (US$, thousands)	Share (%)
High income	8,568,195	73.3
United States	6,137,510	52.5
France	1,456,650	12.5
All others	974,035	8.3
East Asia & Pacific	522,558	4.5
Europe & Central Asia	311,766	2.7
Latin America & Caribbean	1,926,278	16.5
Argentina	1,193,810	10.2
Brazil	597,336	5.1
All others	135,132	1.2
Middle East & North Africa	13,878	0.1
South Asia	155,724	1.3
Sub-Saharan Africa	191,276	1.6
Others	774	0.0
Total	11,690,449	100.0
4.B: Maize imports, 2004		
	Imports (US$, thousands)	Share (%)
High income	8,296,019	58.7
Japan	2,931,850	20.7
Korea	1,431,560	10.1
All others	3,932,609	27.8
East Asia & Pacific	1,433,257	10.1
China	818,609	5.8
Malaysia	330,943	2.3
All others	283,705	2.0
Europe & Central Asia	500,491	3.5
Latin America & Caribbean	2,138,720	15.1
Mexico	745,120	5.3
Colombia	332,085	2.3
All others	1,061,515	7.5
Middle East & North Africa	1,666,104	11.8
Egypt	364,819	2.6
Iran	335,092	2.4
Algeria	298,350	2.1
All others	667,843	4.7
South Asia	76,319	0.5
Sub-Saharan Africa	516,643	3.7
Others	26,016	0.2
Total	14,136,926	100.0

Source: FAOSTAT (http://faostat.fao.org/)

viewpoint, this remains an important distinction because the multilateral trading system has quite different rules in the two cases (see Bouët and Laborde 2010).

In addition, any of these policies may have important beggar-thy-neighbor consequences and may fuel price increases of important commodities. Insulating trade policies imposed by importers and exporters (as well as high-income and developing countries) were indeed responsible for a considerable share of price spikes seen during the 2007/08 food crisis. However, most of the turmoil was likely caused by large exporters and importers. In this sense, policy recommendations should distinguish between larger and smaller countries.

Finally, there is a key asymmetry between net exporters and net importers of an agricultural commodity during a food crisis. Net exporters can benefit from increases in world prices, but net importers are hurt and have no capacity to retaliate efficiently. If large exporting and importing countries cooperate, then it is possible for smaller countries to implement policies to reduce import tariffs and, in the short term, reduce national prices. Clearly, however, any non-cooperation by large importing countries implementing similar policies will neutralize this effect.

19.3.1.2 Food Reserves

Food reserves can be maintained in order to service emergency relief operations, support public distribution of food to chronically food insecure shares of a country's population, and reduce volatility in consumer and/or producer prices, thus stabilizing prices. The basic idea is simple: accumulate food stocks when prices are low (to prevent very low prices that would harm producers) and release them when supply becomes tighter (to reduce very high prices that harm consumers). However, international experience in the management and use of reserves is not clear and is open to significant variation in policies under the Global Food Crises Response Program (GFRP) operations because the so-called strategic grain reserves were not clearly defined.

Timmer (2010) advises governments to hold rice buffer stocks to reduce volatility in the domestic market. Rather than requiring governments to cope with the consequences of food crises, reserves would ensure price stability and prevent acute crises from taking place. However, Timmer's recommendations should be taken with caution, as his analysis is very specific to the rice market, which is much more speculative than other markets.

Gouel and Jean (2012) argue that buffer stocks do not provide relief when there are sharp increases in international food prices. Using a theoretical model for a small open economy, the authors find that buffer stocks might help producers by keeping prices from reaching low levels. However, such stocks do not protect consumers from price spikes without further trade restrictions; this is because small economies are price takers, so domestic prices will follow the international markets (adjusted by transport costs). When prices are high on the international market and there are no export restrictions in place, at least part of the reserves accumulated in buffer stocks will be exported, given that there is no need for local distribution, and will maximize the returns to the commodities being held, which need to rotate to minimize operation costs. While these policies may increase governments' revenues

(exporting their stocks when international prices are high), they do not protect consumers from high commodity prices.

Domestic buffer stocks posit other problems. First, as they aim to control general prices, they are less effectively targeted toward the neediest shares of a country's population (Wright 2009). Second, storage can be expensive, and the poorest countries (which are most vulnerable to food crises) are the ones least likely to be able to afford expensive storage costs (Torero 2011). Third, poor management renders buffer stocks ineffective in many cases. When controlled by parastatals and other government agencies without strong accountability systems, they are potentially subject to political use and mismanagement. Finally, buffer stocks create market distortions; as perishable reserves have to be rotated, their cyclical interventions in the market can send wrong signals to producers and consumers.

For most of these authors, national emergency reserves seem to be a better option than domestic buffer stocks for price stabilization. While buffer stocks for price intervention require considerable stockpiling and subsidize both the poor and the nonpoor, emergency food reserves can more effectively provide aid to the most vulnerable shares of a country's population and entail smaller costs because they require smaller reserves (see Wright 2009). Also, reserves are less likely to create market distortions and disrupt private sector activities (FAO et al. 2011). These mechanisms might prove especially useful for isolated or landlocked countries where, in case of distress, sluggish transportation of food assistance can pose serious threats to vulnerable shares of the population.

The extreme volatility observed during the 2007/08 food crisis suggests that some mechanism of food reserves for price stabilization is necessary to ease the effect of shocks during periods of commodity price spikes and high volatility. (For further discussion of such mechanisms, see Chap. 6 of this book.) There seems to be some consensus around this idea, but policymakers disagree about which specific mechanisms to use to implement such food reserves. As in the case of trade interventions, the most appropriate choices are likely to depend on the characteristics of the specific market under intervention, each country's capacity to cope with crises, and the possibility of establishing international coordination mechanisms. While it likely does not make sense to establish national buffer stocks in most grain markets, Timmer's (2010) support for them may be more valid in a few cases. For example, rice markets might be more speculative than others; thus, price stabilization through buffer stocks makes somewhat more sense in this case. On the other hand, buffer stocks usually entail high costs and market distortions and are prone to corruption. Thus, most countries—especially those with weak institutions and scarce resources—should probably refrain from using stocks and should instead establish emergency reserves for humanitarian reasons.

19.3.2 Medium- and Long-Term Policies

In this section, we summarize the major medium- and long-term policies proposed.

19.3.2.1 Policies to Increase Agricultural Productivity and Resilience

There is a wide array of policies aimed at increasing agricultural productivity and resilience; some of the most widely discussed include:

Input Subsidies

The World Bank (2008) argues that "while development of efficient agricultural input market is a long-term process, this subcomponent (improving smallholder access to seed and fertilizer) would provide rapid support to clients facing immediate and near-term constraints related to seed and fertilizer availability, distribution, affordability and utilization" (p. 90). The plan envisages the implementation of a *market-smart* approach, characterized by: (a) targeting poor farmers; (b) not displacing existing commercial sales; (c) utilizing vouchers, matching grants, or other instruments to strengthen private distribution systems; and (d) being introduced for limited periods of time only.

While they provide a sensible rationale, it is unclear how these principles would be implemented in practice. Poorer countries—which likely have the least developed input markets—may find it difficult to target only those farmers in need. Additionally, subsidy programs that would strengthen, rather than displace, the private sector are likely to require complex mechanisms; institutional weaknesses in poor countries may render these programs unfeasible.

Moreover, these programs usually entail significant fiscal costs. Zaman et al. (2008) estimate that Malawi's input subsidy program costs approximately 3 % of GDP. Importantly, in recent years, rising fuel prices have considerably increased fertilizer costs. If this trend continues in the future, the budget implications of these policies would become even larger.

Finally, more evidence is required to assess the effectiveness of these policies. Dorward et al. (2010) evaluate the 2005/06–2008/09 fertilizer subsidy program in Malawi; their estimates of the benefit–cost ratios of the program range from 0.76 to 1.36, with a (rather small) mid-estimate of 1.06. Arguably, with recent increases in fertilizer prices, a current benefit–cost ratio of the program may be even smaller. Additional potentially adverse impacts of the displacement of private sector operations still require more thorough evaluation and understanding.

Investment in Research and Development

The introduction of high-yield varieties was instrumental for increases in agricultural supply during the 1960s and 1970s. The foreseeable worsening of climatic conditions imposes new challenges, however. Currently, new strands of wheat, maize, rice, and other crops are being developed to have enhanced resistance to droughts, diseases and insects, salinity and other soil problems, extreme temperatures, and floods. In addition, other developments promise enriched varieties with higher nutritional content.

Such policies are highly profitable. Byerlee et al. (2008) find that "many international and national investments in R&D have paid off handsomely, with an average internal rate of return of 43 % in 700 R&D projects evaluated in developing

countries in all regions" (p. 11). However, research and development (R&D) is a typical public good and, as such, faces considerable underinvestment, particularly in developing countries. Thus, governments must expand their expenditures in R&D and must complement this budget increase with other policies. For example, the sustainability of these programs requires private–public participation in the seed industry to generate demand and supply coordination. It also requires strengthening regulatory policies in seed markets, including variety release, seed certification, and phytosanitary measures. R&D should also envisage extension services and other mechanisms to facilitate diffusion and technology adoption by farmers.

Irrigation

Investment in irrigation should be a critical component of any strategy to increase agricultural supply. Irrigation more than doubles the yields of rain-fed areas because more crops can be harvested in any given year; it also at least partially promotes resilience, protecting farmers against droughts. Delgado et al. (2010) estimate that expansion of irrigation infrastructure to all land in developing countries "would contribute about half of the total value of needed food supply by 2050."[12]

Irrigation projects appear to exhibit high rates of return. Jones (1995) analyzes 208 World Bank-funded irrigation projects and finds an average rate of return of 15 %. Despite the importance and impact of such projects, the Global Food Crises Response Program (GFRP) has determined that "under this emergency response program, it is not anticipated that investment support would be provided for new irrigation schemes, as this would be supported under the Bank's regular lending program."[13]

19.3.2.2 Policies to Reduce Postharvest Losses

Developing countries face significant postharvest losses due to mishandling. For cereals, these are estimated to be 10–15 % of harvest; when combined with deterioration in storage (in farms and facilities) and milling, this number can reach 25 %. Poor (or nonexistent) roads compound these losses, as agricultural products cannot reach consumer markets, and information failures impede supply from reaching demand (or at least prevent it from reaching the most efficient markets). Some of the policies discussed to reduce postharvest wastage include:

[12]This would require, however, 40 % more withdrawals of water for agriculture. Thus, these policies should be complemented by increased productivity in existing irrigated areas.

[13]GFRP would limit their financing to: (i) support quick turnaround physical investments in rehabilitation of existing irrigation (small-scale) schemes; (ii) finance investments in rehabilitation or development of field drainage and collector drains to reduce problems of water logging and soil salinity; (iii) finance training for water-user groups and others on operation and maintenance of investments; (iv) finance assessments of groundwater or surface water hydrology and sustainable water use; and (v) finance feasibility studies for medium-term irrigation investments.

Improved Handling of Harvests and Storage Practices

Significant portions of agricultural production are lost due to postharvest mishandling. One example comes from improper drying of crops. If crops are stored in high humidity, they can be affected by mycotoxins and become unfit for consumption. In addition to the risk of growing mold, production stored in improper containers can also attract plagues, insects, and rodents, which can spoil the food. This is only one example of postharvest mishandling in a process where any number of small practices can potentially spoil food. Training in proper drying techniques and building adequate infrastructure in this area can considerably reduce wastage and improve food availability.

The implementation of extension services for postharvest losses should include: (1) training and demonstration of low cost-on-farm storage; (2) technical assistance and investment support for community-level food banks; and (3) training and investment support for grain traders and millers in drying and sorting, as well as fumigation equipment and upgrades in existing storage facilities. These should be complemented with strengthening inspections and quality control surveillance to prevent the spread of pests or diseases.

Information Systems

Imperfect information is especially pervasive in agricultural markets at both the domestic and the international levels. In both cases, a lack of adequate and timely information creates a mismatch between supply and demand. In many cases, the consequence is the allocation of production to suboptimal markets, where the demand is lower. In other cases, severe information constraints can result in agricultural production not reaching any market at all and thus being wasted.

At the domestic level, many countries have implemented agricultural information systems that can be accessed through internet portals, SMS on mobile phones, kiosks, radio shows, etc. The challenge ahead is to find cost-effective mechanisms to produce timely information that can be easily and widely accessed by producers and traders.

At the international level, there is scarce reliable data on stocks and availability of grains and oilseeds. Additionally, there is little monitoring of the state of crops and short-term forecasts based on trustworthy technology (remote sensing, meteorological information, etc.). FAO et al. (2011) proposed the creation of the Agricultural Market Information System (AMIS), which involves major agricultural exporters and importers, as well as international organizations with expertise in food policy. It comprises two organisms: the Global Food Market Information Group (to collect and analyze food market information) and the Rapid Response Forum (to promote international coordination). While the specific details of its duties and membership (and the political negotiations surrounding them) still need to be addressed, AMIS is a first step in answering the need for global information and coordination mechanisms.

Rural Roads

Transport infrastructure plays an important role in the reduction of both the level and variability of food prices. Without roads to transport their agricultural production, some farmers cannot reach consumer markets; others have market access, but at a very high cost. Delgado et al. (2010) argue that, in most cases, transport costs represent 50–60 % of total marketing costs. Byerlee et al. (2008) estimate that less than 50 % of the rural African population lives close to an all-season road. Transport infrastructure can also help reduce price variability. Roads are useful means to spread out regional shocks; if a certain region is hit by a shock (weather or other), it can import food from another region. For example, during the food crisis, regions with better infrastructure in Indonesia were not hit as hard as those poorly connected.

19.4 Analysis of Consistency

The question that this section tries to answer is how consistent or inconsistent the operational policy recommendations have been with respect to: (a) Proposals of International Organizations and the G8's document prepared for the Ministers of Finance Meeting in 2008 and (b) the different policy recommendations proposed by key researchers and analyzed in detail in the previous two sections. With this objective in mind, we analyze as an experiment the portfolio of loans of GFRP operations detailed in Table 19.5, covering operations in 13 developing countries. Table 19.6 provides a detailed summary of all these World Bank operations which have as their core objective the mitigation of the impact of the food crisis.

Table 19.5 Documents analyzed for GFRP operations

Country	Project ID	PAD	ICR
Mozambique	107313	✓	✓
Djibouti	112017	✓	✓
Honduras	112023	✓	N/A
Haiti	112133	✓	N/A
Bangladesh	112761	✓	✓
Sierra Leone	113219	✓	✓
Madagascar	113224	✓	✓
Rwanda	113232	✓	N/A
Burundi	113438	✓	✓
Philippines	113492	✓	✓
Guinea	113625	✓	✓
Mali	114269	✓	N/A
Cambodia	117203	✓	✓

Note: PAD is Project Appraisal Document of the World Bank and ICR is the Implementation, Completion and Results Report of the World Bank

Table 19.6 Summary of selected World Bank operations to mitigate the impact of the food crisis

	Trade policy	Food reserves	Social protection	Supply policies	Others	Remarks
Mozambique	– Remove import duties on diesel and kerosene (and also VAT on diesel) – In 2008, these measures (and an additional urban transport subsidy) entailed spending 0.8 % of GDP – This is a large expenditure compared to the "Food Production Action Plan" (0.5 % of GDP)		– Government expanded the Food Subsidy Program (PSA), a direct cash transfer to eligible households – PSA increased beneficiaries by 20 % and benefits by 50 %	– Government approved "The Food Production Action Plan."[a] This plan includes: support for technology adoption, development of agricultural services, provision of high-quality seeds, construction of storage silos, agricultural service delivery (research, finance, etc.), linking smallholders to markets, and stimulating demand for local food – Promote the construction and rehabilitation of agricultural infrastructure and increase access to agricultural technologies and extension information – Improve quality for road infrastructure	– Improve budget process and use of public expenditures, improve revenue collection, public financial management procurement system, (internal and external) audit bodies, human resource management in the public sector, etc.	– In general, "the government intends to allow the pass through of international prices of food and fuel to the domestic economy, notably envisaging no trade distortions or generalized subsidies, while protecting the economic sectors most vulnerable to the increase in energy prices" (PAD, pgph. 80)

(continued)

Table 19.6 (continued)

	Trade policy	Food reserves	Social protection	Supply policies	Others	Remarks
Bangladesh	– Government removed custom duties for rice and wheat.	– Increase the targeted size of public food stock from 1 million to 1.5 million tons – At least, part of the objective is to use them for price stabilization purposes[b]	– Increase budget of seven existing social protection programs: Open Market Sales (OMS), Test Relief Food, Gratuitous Relief for Food, Food Assistance in CTG-Hill Tracts Area, Food for Works, Vulnerable Group Development, and Vulnerable Group Feeding – However, there seem to be considerable leakages (PAD, Annex 4, pgph. 7–8) – Creation of the 100-Days Employment Guarantee Program	– Bring the fertilizer distribution network closer to farmers (from the *upazilla* to the union level) – Increase government's rice procurement price to stimulate production	– Increase tax collection – Prices of petroleum products, urea fertilizer, and compressed natural gas (CNG) were heavily subsidized by SOEs. Government reduced SOE's deficit through prices increases	– Government aspires to become self-sufficient in rice production: "since the availability of rice trade in international trade can no longer be taken for granted and with Indian rice export restrictions continuing, the talk in Dhaka has moved from imports to complete self-reliance" (source: PAD) – No improvements in targeting mechanisms of social programs (which have considerable leakages)
Philippines	– Government runs the National Food Authority (NFA), which is the sole entity allowed to import rice, regulate rice trading, and determine farm gate support and retail price stabilization	– NFA to release rice buffer stocks in periods of price increases	– Government increased budget for existing social protection programs (see PAD, Annex 5)		– The operation does not include policies to enhance agricultural production. However, other government initiatives do	– The government is striving for rice self-sufficiency which, according to technical analysis, might have actually undermined food security

	– Initially, NFA aggressively sought to increase their stocks with large import tenders, which exacerbated price volatility – Subsequently, NFA decided to suspend rice tenders and established bilateral deals with Japan and Vietnam – In the medium-term, the Philippines is due to lift quantitative trade restrictions on rice by WTO agreements	– The government allocated temporary rice import quotas, rather than solely relying on NFA imports. However, as domestic prices were lower than international prices, the incentive failed – In the medium-term, the government is supposed to transfer rice trade to the private sector (as envisioned in the Medium-Term Philippine Development Plan) – The Philippines is trying to push a regional rice reserve mechanism through ASEAN	– However, the most significant social protection program remains NFA with a budget of $1.2 billion for 2008. NFA is poorly targeted and under-covers the poor[c] – The government launched a CCT (Pantawid Pamilya), conditional on children's school attendance and health checkups – Coverage of the CCT is based on the National Household Targeting System for Poverty Reduction (NHTS-PR). NHTS-PR is a proxy means test for beneficiary selection and the government is adapting other programs' coverage accordingly – The Food for School program is implementing geographic targeting, prioritizing the 20 poorest provinces and the 100 poorest municipalities		– Government launched FIELDS (Fertilizer; Infrastructure and irrigation; Extension and education; Loans; Drying and other postharvest facilities; and Seeds) program. Rather than creating new programs, FIELDS is an acceleration and scaling up of the existing production programs – Government has also subsidized seeds and fertilizer to farmers. However, there appears to be considerable leakage and mismanagement (PAD, pgph. 55–56)	– NHTS-PR would "provide the government with the vehicle to re-direct more inefficient subsidies that are not well-targeted to the poor (such as the NFA rice subsidy) to more targeted programs and possibly cash-based programs in the future" (source: PAD)

(continued)

Table 19.6 (continued)

	Trade policy	Food reserves	Social protection	Supply policies	Others	Remarks
Djibouti			– There are limited social protection mechanisms in Djibouti. WFP provides emergency food assistance in rural areas, but coverage is small. Government is planning to expand this program in cooperation with UNICEF and local NGOs – Besides this, as the food crisis unraveled, there were no major existing social assistance programs to scale-up. The government's immediate policy was to implement an untargeted policy and eliminate the consumption tax rate on five basic food items (rice, sugar, cooking oil, wheat flour, and powder milk) – However, this policy was mostly ineffective: there was a low pass-through from reduced tax rates to consumer prices.[d]	– The government implemented a fisheries' support program to increase food supply and increase immediate fish output. The program provides training in modern techniques, boats, and microcredit to young fishermen – Government implemented a program for external agricultural production in Ethiopia and Sudan	– Rehabilitate ten community wells in rural areas. These wells will provide support to nomadic pastoralists who have been severely affected by recent droughts	– "The impacts of the measures supported by this program were expected to have a regressive distribution. In particular, the main intervention supported by this operation (tax exoneration of food items) was untargeted and therefore benefitted richer households as much (or relatively more) than poorer households. However, given the large size of the poor population (74 %), the intervention was considered to have an immediate relief on poor households" (ICR, pgph. 59)

			Possible explanations for this outcome are: (a) the high concentration of the food market in Djibouti with few importers and distributors and (b) heightened security risks posed by pirates in international waters – Government has drafted an action plan to suggest ways to improve targeting and direct support for the poor. As part of this, Djibouti completed a population census[e]			
Honduras		– Government to fund the purchase and storage of strategic grain reserves (US$9.5 million)	– Increase PRAF, an already existing CCT program, from 148,000 to 200,000 beneficiaries through an IADB $20 million operation – Government implemented PASAH (Program Supporting Food Security in Honduras), targeted to female-headed households in poor areas. PASAH provides support for productive activities with funds from the European Community	– Enactment of the Emergency Law to Prevent the Shortage of Basic Grains[f] – Loans for medium and smallholders (3.5–35 ha) at favorable terms through BANADESA (National Bank for Development) – Subsistence producers (<3.5 ha) to benefit from a technological package of improved seeds, fertilizer, and technical assistance	– Increase budget allocation for SENASA—National Service of Agricultural and Animal Health (US$1.5)	– Most of these initiatives are part of a more general response to the food crisis by the Honduran government – However, the proposed operation seems to be more oriented to release funds for the government to aid the financial sector – The government is concerned about the effect of increasing food prices on households' real income. This is expected to have an adverse effect on banks' outstanding portfolio of consumer loans

(continued)

Table 19.6 (continued)

	Trade policy	Food reserves	Social protection	Supply policies	Others	Remarks
				– BANADESA also to finance the expansion of small scale irrigation projects – The government is implementing the "Price Risk Management of Agricultural Commodities in Honduras" project, with funding from the World Bank and IDB – The government is also implementing the Second Road Rehabilitation and Improvement Project, which seeks to rehabilitate secondary roads		– The PAD argues that "The supplemental financing will be an important source of budget financing for the government, providing fiscal space to continue responding to the food crisis, while helping to maintain the macroeconomic stability that led the IMF board to approve a stand-by agreement on April 7, 2008. Timely program support will also assist government efforts to strengthen the financial sector in a period characterized by exogenous shocks that could potentially weaken some banks" (PAD, p. 11)
Haiti			– Rising food prices led to riots and the resignation of the Prime Minister in April 2008. The government announced a temporary subsidy to reduce the price of rice as an emergency measure. Between May and December 2008, the estimated budget for this subsidy was US$30 million	– The third priority area of the "Program of Action against the High Cost of Living" is to scale up agricultural inputs and investments to boost agricultural production		– Since 2004, the World Bank has supported two Economic Reform Governance Operations: ERGO I (US$61 million) and ERGO II (US$23 million)

			– The government, in coordination with donors, drafted the "Program of Action against the High Cost of Living." Two priority (of the three) areas of this plan are: (i) employment generation through labor-intensive works and (ii) expansion of food assistance programs—including feeding programs for schoolchildren, mothers, and infants—for 6 months			– The World Bank's objective appears to be the sustainability of these operations. "The urgent need for public expenditures to respond to the food crisis in the wake of the riots has resulted in higher financing requirements than originally anticipated. This supplemental financing grant will enable the government to continue to make progress on the reform program supported by EGRO II which could otherwise be jeopardized by the unanticipated gap in financing for the 2008 budget" (PAD, pgph. 35)
Cambodia	– Cambodia implemented a ban on rice exports in March 2008, fueling rice price increases in international markets		– Expansion of the Identification of Poor Households Targeting Program.[g] This targeting mechanism is mostly used by Health Equity Funds (HEF) and, to a more limited extent, ADB-supported Emergency Food Assistance Project. However, it will be applied to a broader range of safety net interventions	– Improve access to and transparency of seed and fertilizer markets: These policies include the suspension of VAT for fertilizers; distribution of seed and fertilizer vouchers for farmers with less than 1 ha of land; and a pilot for "smart subsidies"	– Improve the governance and effectiveness of government emergency response and crisis policy actions through quarterly reports, including an independent monitoring component	

(continued)

Table 19.6 (continued)

	Trade policy	Food reserves	Social protection	Supply policies	Others	Remarks
	– In May 2008, when harvest prospects improved, the ban was lifted – The government has a new focus promoting rice production, improving price incentives through expansion of official rice exports: the "Policy Document on the Promotion of Paddy Rice Production and Export of Milled Rice" sets a target of 1 million tons of milled rice exported by 2015		– Design of a food and cash for work program – Government to provide WFP with 2000 MT per year over 3 years to increase food distribution through school feeding and food for work programs	– Additionally, the government is concerned by high market concentration and quality problems in the fertilizer market. Thus, the government is strengthening its regulation of this market. However, most of fertilizer quality problems can be traced back to production in Vietnam rather than adulteration in Cambodia – Strengthen the role of community-based farmer organizations to access inputs and credit, technical support and market and policy inputs – Boost credits for investments in higher quality milling facilities, "which serve as a key interface between smallholders and markets in terms of quality standards an input supply" (PAD, pgph. 67)		

Mali	– The government introduced a 6-month tariff and VAT exemption for rice. In return of this measure, traders committed to hold their prices (at US$7.2/kg). However, prices rose considerably afterwards	– During the crisis, the government released grain stocks held by the Food Security Commission – Government is revising its guidelines to "establish a more efficient and transparent management system as well as developing countercyclical marketing measures to stabilize cereal prices, e.g., selling cereals during the hunger season in July–September when prices are at their highest level" (PAD, pgph. 12) – "A recent USAID review concluded that Malian authorities have been quite effective in stock management and in their attempts to use the grain stocks to stabilize local food prices" (PAD, pgph. 14)	– "The government's social safety nets, mainly consisting of school feeding and nutrition programs, are small in scale and poorly targeted, with limited impact on the ground" (PAD, pgph. 10). However, the operation does not include any policies to strengthen safety nets	– Government is implementing the Rice Initiative. This includes: "(i) measures to improve crop input distribution by increasing the availability of seed for locally-produced rice varieties; (ii) new/expanded subsidies on crop inputs; (iii) measures to improve marketing channels, with the objective of facilitating the commercial relationship between producer organizations; and (iv) subsidies for equipment, access to water/irrigation, and extension services" (source: PAD)	– The government froze nonessential spending for 6 months to accommodate to budget pressures from the food crisis – This has affected delivery of public services	– Poverty Reduction Support Credit (PRSC) is an important piece of the World Bank's strategy in Mali. Its second phase (PRSC II) was approved by the Board in May 2008 (US$42 million) – This GFRP operation provides supplemental financing for PRSC II – "The urgent policy measures put in place to combat high food prices have put extraordinary pressures on the national budget. The proposed supplemental financing would . . . help the Government of Mali fill in an unanticipated financing gap caused by the food crisis and thus maintain the course of important socioeconomic policy reforms agreed under the PRSC-II and GPRSP" (PAD, pgph. 32)

(continued)

Table 19.6 (continued)

	Trade policy	Food reserves	Social protection	Supply policies	Others	Remarks
Guinea	– Reduced custom duties for low quality rice from 12.75 to 0 % (original target was 2.5 %) between June 1 and October 31, 2008 – Guinea imposed a ban on agricultural exports applicable for 2007.[h] In 2008, the government issued a ministerial order clarifying that the agricultural export ban was no longer in place, with the exception of rice – The government envisaged to replace the rice export ban with export taxes and committed to a study for its implementation. However, the new de facto government has reinstated the rice ban	– The government plans to build "an emergency food reserve of 25,000 metric tons" (source: PAD). Documentation does not specify whether these reserves would act as humanitarian or buffer stocks	– The government negotiated with rice importers, unions, and civil society to control wholesale and retail profit margins (GNF 1000 and 2000 per 50 kg bag, respectively) – Distribution of take-home rations for children of families of five or more members – Emergency school feeding and nutrition support – Implementation of an "Emergency Urban Labor-Intensive Public Works Program," which includes road maintenance and urban works programs aimed to provide employment and income to affected households	– "Emergency Agricultural Productivity Support Program," which includes: (i) production of 2000 certified seed, (ii) procurement of 2,000 tons of fertilizer, and (iii) distribution of input packages to 70,000 smallholder farmers		– "Since the coup in December 2008, the Bank's engagement and activities in Guinea have been on hold. Management has invoked the provisions of OP/BP7.30, dealing with de facto governments. Contacts with the Guinean regime have been limited to technical correspondence on the fiduciary issues. Currently, Guinea is under suspension of disbursements for non-payment (over 60 days)" (ICR, p. 17)

Burundi	– Temporary exemption of transaction taxes and import duties for 13 staple products (beans, maize, potatoes, etc.) – These temporary measures were applied until July 2009, when an 18 % VAT was introduced and Burundi began to apply the common external tariff of the East African Community		– Scaling-up WFP's School Feeding and Nutrition Program for Primary Schools (SFNP). Originally, the government budgeted US$3 million to serve 120,000 children. However, it only allocated US$2.4 million and benefited 88,164 children – The operation also supported increased budget allocation to aid refugees returning to the country after a ceasefire was enacted		– Though not part of this operation, the government is implementing other policies through different funding sources (AfDB, Belgium, Netherlands, Norway, etc.): exempt diesel from transaction taxes and import duties, subsidies for diesel in pro-poor sectors, distribution of agricultural inputs, rehabilitation of irrigation systems, etc.	
Madagascar			– Expansion of food for work and school feeding Programs. An estimated US$10 million are to be allocated	– The government is implementing a rice intensification campaign to boost production in the short run. The campaign aims to increase productivity in existing rice lands and to start rice production in areas that would not normally grow rice (US$20 million)	– Elimination of a VAT for rice (from an original level of 20 %). It is expected that this measure would translate into reduced consumer prices due to the high degree of competition in the rice market	– The World Bank is implementing a longer-term strategy in Madagascar through a Poverty Reduction Support Credit (PRSC)

(continued)

Table 19.6 (continued)

	Trade policy	Food reserves	Social protection	Supply policies	Others	Remarks
				– Specifically, this program would "strengthen the supply of farming system development technology packages geared at promoting intensification of rice cultivation. The program will be implemented by service providers who will be contracted through producer associations and through the subsidization of the selected technology package via the intermediation of microfinance institutions" (PAD, Annex 1, pgph. 6)	– Elimination of rice VAT would entail a fiscal loss of US$20 million – The World Bank is preparing two additional financing proposals for two existing credits ("Community Development Fund" and "Rural Development Projects") to strengthen safety nets and boost agricultural productivity in the medium term	– The Bank approved the PRSC-5 (the second component of the second PRSC series) in May 2008. The PRSC-5 aims at "complementing the significant portfolio of ongoing International Development Association investment projects targeting infrastructure, environmental protection, mining, rural development, integrated growth poles, irrigation and watershed management, and regional telecommunications" (PAD, pgph. 13) – In this line, the current operation would "enable the government to continue to make progress on the reform program supported by the PRSC program, which would otherwise be jeopardized by the unanticipated gap in financing for the 2008 and 2009 budgets, including the maintenance of a stable macroeconomic framework" (PAD, pgph. 23)

Sierra Leone	– Temporary reductions in import duties for the following products: • Rice (from 15 to 10 %) • Flour (from 20 to 10 %) • Wheat (from 5 to 2.5 %) • Sugar (from 20 to 10 %) – Additionally, the fixed reference price to value rice imports was established at US$375 per metric ton (well below prevailing world price) – The import duty on petroleum was reduced from 5 % of CIF ad valorem to US$20 per metric ton. Excise taxes on petroleum were also reduced – As the international price of petroleum reduced significantly, its tariffs and excise taxes were restored to precrisis levels – While there have been some reductions in the price of rice, sugar, wheat, and flour, these have not returned to their precrisis levels, and the tariff reductions were maintained		– The government protected the provision of selected basic services from the rising costs of food and fuel – Specifically, the government seeks to protect food aid provided to the following vulnerable groups: • Hospital patients in district hospitals and community health centers • Lactating mothers and children under five in hospitals • Pupils in government boarding schools and handicapped children • Children in remand homes and approved schools who receive food	– Government provided 71,000 bushels of seed to rice farmers	– Government used funds from a strategic petroleum reserve to subsidize petroleum prices for 5 weeks between June and July 2008 – The World Bank approved a separate GFRP grant of US$4 million in August 2008 to support a cash-for-work program. An additional US$4 million GFRP grant was approved in November 2009 to scale-up this program – Other World Bank operations aim to increase agricultural production in the medium and long run: the Rural and Private Sector Development Project (US$30 million) and the Infrastructure Development Project (US$55 million)	– The World Bank supports Sierra Leone's Poverty Reduction Strategy (PRS). The 2005–07 PRS established three action pillars: (i) good governance, security and peace building; (ii) pro-poor sustainable growth for food security; and (iii) human development – At the time of the operation, the government was preparing the 2009–11 PRS – "The proposed grant of US$ 3 million equivalent would support the Government's PRS by providing the authorities with needed fiscal space to partially compensate for the lost revenues resulting from the recently reduced tariffs on food and fuel imports. This support would help mitigate the impact of such price increases and contribute to continued basic service delivery for vulnerable groups" (PAD, pgph. 5.1)

(continued)

Table 19.6 (continued)

	Trade policy	Food reserves	Social protection	Supply policies	Others	Remarks
Rwanda				– Government implemented the Crop Intensification Program (CIP), providing improved seeds and fertilizer – There was a pilot project for fertilizer distribution during the 2008 season: in order to negotiate lower prices, the government engaged in bulk purchases. Subsequently, the government directly distributed fertilizer at subsidized prices through farmer loans – Albeit production increases in CIP, only 4 % of fertilizer loans from the pilot were recovered – Additionally, increases in international prices are likely to create large fiscal deficits for the program – The government will implement reforms regarding the CIP. While it will still buy fertilizer in bulk quantities, it will carry out auctions to private sector operators who bid for it. The government will subsidize successful bids below the cost.	– World Bank is implementing other projects to increase agricultural production in the medium and long run. These include: irrigation infrastructure, and access to rural microfinance	– Funds provided by this operation can only be used to fill in the immediate needs for the food crop intensification program. However, fertilizer for export crops (such as tea and coffee) can be purchased with government resources or funds from alternative donors (e.g., AfDB) – There are inherent risks to this project: sustainability[j], mis-targeting, crop leakage, collusion, rent seeking, poor cost recovery, etc. However, no ICR report is available

				There will be additional subsidies based on a voucher system. Credit for farmers to purchase fertilizers will be provided by the private sector[i]		

[a] See PAD, Box 3

[b] While partially increased for humanitarian purposes ("to ensure that there is enough food in the country to feed the population in a crisis when import channels may be temporarily blocked"), there are also price-strategic purposes ("to ensure that the food stock is large enough to influence, if necessary, the open market price . . . "). See: PAD, pgph. 64

[c] "Evidence shows that this is not well targeted to the poor. Based on the FIES 2006, NFA rice accounted for only 13 % of the total spending on rice by the poorest quintile. Moreover, 40 % of NFA rice is not consumed by the poor. Only 31 % of the total consumption of NFA rice goes to the poorest quintile" (PAD, pgph. 39). Due to these leakages, the government implemented family access cards to poor households in Metro Manila. Some 270 thousand cards have been issued, but admittedly "the method used to identify the poor has been less than optimal."

[d] The ICR suggests that: (a) "the difference between domestic and international prices [*of tax-exempted items*] was higher in all but one case, that of sugar, after the removal of taxes in Djibouti"(ICR, pgph. 38) and (b) "except for sugar, the results reveal that the mark-up on domestic food markets was higher than the one in international markets" (ICR, pgph. 39)

[e] This is considered a major milestone since all previous population statistics were based on a 1991 demographic survey (ICR, pgph. 52)

[f] This includes: (i) support for productive infrastructure, (ii) technological inputs, (iii) financial instruments to mitigate both credit and agricultural risk, (iv) enhanced grain storage facilities, and (v) food security

[g] This is a participatory system: "the identification process is carried out by village representatives, with the support and supervision of the commune council, as well as district-level representatives. Village representatives are responsible for conducting household interviews, assessing household "poverty scores" according to the information gathered through the interviews, and preparing draft lists of poor households. Draft lists are then displayed in public locations, so that villagers are able to view them and possibly complain during or following the village consultation meeting, held before the final list of poor households is submitted to the commune council" (PAD, pgph. 48)

[h] "The clarified policy stance on the export of agricultural produce helped in particular the small agricultural producers which had developed a successful regional trade in a number of agricultural markets. It was estimated by the Guinean association of potato growers that these alone had lost the equivalent of US$ 8,000 a day, when exports were banned" (ICR, p. 13)

[i] "There is currently an information and sensitization campaign underway with the union of popular banks and micro-finance institutions. The aim of the campaign is to inform farmers of the fertilizer program and the potential need for access to finance, and the potential returns. Technical modifications of the Agricultural Guarantee Fund (AGF) have been proposed to reduce the transaction costs for microfinance institutions to access the AGF, thereby providing market-based incentives for participation. It is fully expected that leaving the credit side to financial institutions—which are more equipped than government to make and recover loans—will result in much higher loan recovery rates compared to levels last year" (PAD, pgph. 17)

[j] The PAD claims that "as fertilizer prices normalize, and as farmers become more familiar with the benefits associated with fertilizer application, the need for explicit subsidies will diminish leading to a sustainable system. The global experience of the IFDC has been that during the first few years of the auction, private sector participants become aware of the large profits to be made in the activity. As a result, there is a gradual increase in the average level of bids submitted for the fertilizer lots. This in turn progressively reduces the government's subsidy at the auction level. Secondly, the voucher system is designed to enable the government to gradually withdraw or reduce the level of the subsidy, at any point in time. This would involve a gradual reduction in the discount specified on the printed voucher. As the situation improves, this would eventually lead to a cessation of the distribution of vouchers. Furthermore, in Rwanda, the government has already started actively promoting (among coffee and tea participants) private sector group bulk purchase of fertilizer. The aim here is for government to withdraw from this area, as elaborated in the Fertilizer Strategy" (PAD, pgph. 8). However, the sustainability of this policy seems to rely on a large number of assumptions

Table 19.7 Summary of operations

	Official position of World Bank during 2007/08		Policies recommended by the World Bank after 2008	
	Consistent	Not consistent	Consistent	Not consistent
Mozambique	X		X	
Bangladesh	X			X
Philippines	X		X	X
Djibouti	X		X	X
Honduras	X			X
Haiti	X		X	X
Cambodia	X	X (export ban)	X	X
Mali	X	X	X	X
Guinea	X	X (export ban)	X	X
Burundi	X		X	X
Madagascar	X		X	X
Sierra Leone	X	X	X	X
Rwanda		X		X

Following an assessment of each of the specific operations for the 13 developing countries, benefits are analyzed and summarized in Table 19.7:

(a) **Mozambique**: Overall, consistent with the policy recommendations in 2007/08 and after 2008. The government allowed a pass-through of international prices while protecting vulnerable groups (expanding PSA program). In addition, through the GFRP operation, the World Bank supported the implementation of reforms to increase agricultural productivity through the provision of infrastructure and public goods (technology adoption, construction of silos, agricultural infrastructure, etc.).

(b) **Bangladesh**: Overall, consistent with the policy recommendations on trade in 2007/08 but not consistent with later World Bank research after 2008. Specifically, the GFRP operation was used in accordance with the GFRP framework to support the reduction of import duties for rice and wheat, and there was an increase of public food stocks (at least partially to act as price buffers) from 1 to 1.5 million tons. On the other hand, it is important to mention that the increased public targeting for aid programs was positive in terms of performance of the program in identifying the proper beneficiaries. However, most of it was untargeted and had severe leakages (e.g., large share of budget allocated to open market sales).

(c) **Philippines**: The GFRP operation resulted in a combination of policies which were consistent with the official World Bank policy recommendations in 2007/08 and were both consistent and inconsistent with the post-2008 recommendations. On the consistent side, as a result of the GFRP operation, the government launched the Household Targeting System for Poverty Reduction (NHTS-PR) and introduced a CCT (Pantawid Pamilya). In addition, the NHTS-

PR will become a targeting instrument for other social programs, and the Food for School Program is prioritizing the poorest provinces and municipalities to enhance targeting of the most vulnerable share of the population. Finally, the government pushed for a regional rice reserve mechanism through ASEAN, which is an emergency regional rice reserve to assure food security in the region and which has a very clear trigger mechanism and governance. In addition, the country was engaged in large rice import tenders, exacerbating increases in international food prices, but the GFRP made the government commit, as part of the loan, to change its tendering policy in a way that would reduce prices. The government also agreed to withdraw a big tender that was going to increase price pressure in the international market. Finally, bilateral rice deals were established, reducing pressure on external markets. These policies, although consistent in the short term with the GFRP framework, are inconsistent with later World Bank recommendations. In the medium term, the government is due to lift quantitative trade restrictions by WTO agreements, and there is a medium-term plan to transfer rice trade to the private sector. However, currently the National Food Authority (NFA) has the monopoly over rice imports. NFA still concentrates a significant proportion of its food aid budget, which is poorly targeted. NFA's reserves act as a buffer stock for price stabilization.

(d) **Djibouti**: The GFRP operation resulted in a combination of policies which were consistent in general with the official World Bank policy but which, at the same time, were inconsistent with the policy recommendations after 2008. On the consistent side, when the crisis started, there were few social protection mechanisms; the government was able to expand the WFP-operated food assistance program in rural areas (one of the few existing) with GFRP support. It also completed a population census as a first step to implement direct and targeted protection mechanisms for the poor and provided support for fisheries to boost food production. On the inconsistent side with the post-2008 recommendations but consistent with the GFRP framework and official policy of the World Bank, the government eliminated the consumption tax rates on five basic staples; this policy was not effective in reducing consumer food prices. Low pass-through rates were probably due to high concentration in the food market (few importers and distributors) and security risks posed by pirates in international waters.

(e) **Honduras**: Overall, consistent with the policy recommendations. The proposed operation seems to be more oriented to releasing funds for the government to aid the financial sector, given the government is concerned about the effect of increasing food prices on households' real income; therefore, the government uses the resources as a buffer to mitigate the expected adverse effect on banks' outstanding portfolio of consumer loans. However, the financial sector was not the real target of the operation; it was just the fastest way to transfer cash to the government for more general crisis response policies.

(f) **Haiti**: The GFRP operation resulted in a combination of policies which were both consistent and inconsistent with the policy recommendations. On the consistent side, as a result of the GFRP, a "Program of Action against the

High Cost of Living" (with a focus on employment generation through labor-intensive works and expansion of food assistance programs) was developed. In addition, the government also implemented what they refer to in the GFRP framework as a second best policy, i.e., subsidies to reduce the price of rice between May and December 2008 (US$30 million). However, there are specific circumstances that need to be met for the Bank to accept this type of policy (see GFRP Framework document p.26, para. B2). Moreover, post-2008 these policies were not supported.

(g) **Cambodia**: The GFRP operation resulted in a combination of policies which were consistent with the GFRP framework and official position of the World Bank. Despite the initial ban on rice exports in March 2008, they lifted this ban in May 2008 and are currently seeking to promote rice production. The main policy is to create price incentives by promoting exports (goal of one million tons of milled rice exported by 2015). In addition, they expanded the "Identification of Poor Households Targeting Program" to be applied to safety nets, implemented food for cash and food for work programs, and boosted credit for milling facilities which act as an interface between smallholders and markets. In addition, consistent with the GFRP framework and official World Bank position in 2008, the GFRP operation subsidized fertilizers by the suspension of the VAT and by implementing a pilot for "smart subsidies" using vouchers to be distributed to smallholders. However, this type of policy was not recommended post-2008, given (as it has been shown in the case of Malawi) that it bears the risk of significant fiscal deficit. Finally, the government regulated the fertilizer market in principle to avoid adulteration; however, most of the adulteration appears to happen in Vietnam (from where fertilizer is imported) rather than in Cambodia.

(h) **Mali**: The GFRP operation resulted in policies which were both consistent and inconsistent with the official policy recommendations of the World Bank and with what was recommended after 2008. On the consistent side, the government increased seed availability for locally produced rice varieties and improved marketing channels to facilitate relationships between producer organizations. Finally, a program of subsidies for equipment, access to water/irrigation, and extension services was implemented. On the inconsistent side, the government introduced 6 month VAT and tariff exemptions for rice, implemented a price-stabilizing buffer stock through the Food Security Commission, introduced subsidies on crop inputs which were not "smart subsidies," and finally, despite acknowledgement of weak safety nets, made no efforts to strengthen them.

(i) **Guinea**: The GFRP operation resulted in a combination of policies which were both consistent and inconsistent with the official World Bank policy recommendations and with the post-2008 recommendations. On the consistent side, in both policies recommended in 2008 and after 2008, the government implemented a safety net system to distribute take-home rations for children of families of 5+ members, an emergency school feeding and nutrition support, and an emergency urban labor-intensive public works program. On the inconsistent side, the country imposed a ban on agricultural exports in

2007; although it was lifted in 2008 for most products, it was not lifted for rice. Although the GFRP operation did not support this, the government could have included a conditionality to be able to obtain the loan. In addition, and consistent with the GRFP framework but not the post-2008 recommendations, with support from the GFRP, the country was able to eliminate custom duties for low quality rice between June 1 and October 31, 2008, and initiated plans to build an emergency food reserve of 25,000 metric tons, although it is not clear if this is for humanitarian or price-stabilizing purposes. Finally, the government implemented the "Emergency Agricultural Productivity Support," which includes the distribution of subsidized seed and fertilizer packages to 70,000 smallholder farmers, although these were not the type of smart subsidies proposed by the GRFP framework.

(j) **Burundi**: The GFRP operation resulted in a combination of policies which were both consistent and inconsistent with the official World Bank policy recommendations. On the consistent side, the government scaled up WFP's school feeding and nutrition program. However, funds allocation and the number of beneficiaries fell short of initial goals. In addition, the government supported the return of refugees to the country. Finally, and consistent with the GRFP framework but inconsistent with post-2008 recommendations, the government implemented exemption of transaction taxes and import duties until July 2009.

(k) **Madagascar**: The GFRP operation resulted in a combination of policies which were consistent with the official World Bank policy recommendations. The government expanded the food for work and school feeding programs and introduced a rice intensification campaign through producer associations. This program aims to provide subsidies for selected agricultural technologies through microfinance institutions. Finally, the government eliminated the VAT for rice, which, although consistent with the GFRP framework, was not consistent with post-2008 recommendations.

(l) **Sierra Leone**: The GFRP operation resulted in a combination of policies which were both consistent and inconsistent with the official World Bank policy recommendations. On the consistent side, the government protected selected basic services from increasing costs of food and fuel (those for hospital patients, lactating mothers, government's boarding schools, etc.). In addition, the tariffs for four products were reduced; this reduction is to be maintained until prices return to precrisis levels. On the inconsistent side, the government provided fully subsidized rice seed to farmers (71,000 bushes), which were not targeted as the "smart subsidies" strategy recommended in the GFRP.

(m) **Rwanda**: The GFRP operation resulted in policies which were inconsistent with both the official World Bank policy recommendations and the post-2008 recommendations. Specifically, the government implemented the Crop Intensification Program for food crops which included significant market intervention by the government: (a) purchasing fertilizers in bulk in international markets; (b) auctioning fertilizer to private traders; (c) promoting private microcredit for smallholders; and (d) providing additional targeted subsidies through vouchers.

This program has significant risks: mis-targeting, crop leakage (i.e., cannot be used for export crops), collusion among traders, and an extremely low loan recovery rate (during a pilot in 2008, recovery was only 4 %).

19.5 Final Remarks

The world faces a new food economy that likely involves both higher and more volatile food prices, and evidence of both conditions was clear in 2007/08 and 2011. After the food price crisis of 2007/08, food prices started rising again in June 2010, with international prices of maize and wheat roughly doubling by May 2011. This situation imposes several challenges. In the short run, the global food supply is relatively inelastic, leading to shortages and amplifying the impact of any shock. The poor are hit the hardest. In the long run, the goal should be to achieve food security. The drivers that have increased food demand in the last few years are likely to persist (and even expand). Thus, there is a significant role for the World Bank to play in increasing the countries' capacity to cope with this new world scenario and in promoting appropriate policies that will help to minimize the adverse effects of the increase in prices and price volatility, as well as to avoid exacerbating the crisis.

In this regard, this chapter describes some of the most important official policies that the World Bank prescribed to different countries during the food crisis of 2007/08. In addition, it compares those policies to what was proposed by World Bank research after 2008. The chapter focuses on the proposed short-term, medium, and long-term policies. In terms of short-term policies, two mechanisms are emphasized: support for the poor and price stabilization (with an emphasis on trade restrictions and food reserves). In terms of medium- and long-term policies, we focus on the recommendations linked to increasing agricultural productivity through productivity gains and elimination of postharvest losses.

In support of the poor, Targeted Cash Transfers (TCT) and Conditional Cash Transfer (CCT) programs already in place clearly constitute first-best responses for several reasons: (a) they prioritize assistance for targeted groups, (b) they do not entail additional costs of food storage and transportation, (c) they do not distort food markets, and (d) in the case of CCTs, they explicitly prevent human capital deterioration. When TCTs and CCTs are not available, governments may also implement other types of assistance programs, although this could bring some inefficiency. Therefore, in poor countries where TCTs and CCTs are not yet in place (such as most Sub-Saharan Africa), it is essential that during noncrisis years, countries invest in strengthening existing programs—and piloting new ones—to address chronic poverty, achieve food security and human development goals, and be ready to respond to shocks. Across the different GFRPs, we see these policies implemented by the World Bank, specifically in the Philippines, Djibouti, Haiti, Cambodia, Guinea, Burundi, and Madagascar.

In terms of short-term price stabilization policies through trade policies and management of food reserves, we identify important inconsistencies in what was recommended in the official position by the World Bank, through the GFRP

framework document and in the G8's document prepared for the Ministers of Finance Meeting in 2008, and in post-2008 recommendations. Clearly, the official recommendations in 2008 were more flexible, especially in regards to trade policies and physical reserves, and in some cases allowed short-term interventions that could end in pervasive market distortions. As a result, most of the operations under the GFRPs were consistent with the official policy recommendations with the exception of Cambodia, Guinea, Sierra Leone, and Rwanda (see summary in Table 19.7).

On the other hand, if we look at the post-2008 recommendations, all of them will avoid any potentially pervasive market distortions. Even more, regarding trade policies, most of the work of the World Bank will advise against any trade restrictions (on both the import and the export side). In that sense, if we assess ex post the GFRP operations, we find that in many of the countries, the policies implemented as a result of the GFRP created additional trade restrictions other than export bans, which was the only bad policy identified in the GFRP framework document. This was the case for Bangladesh, Philippines, Mali, Guinea, Burundi, and Sierra Leone.

Nevertheless, and as explained in Sect. 19.3, it is important to mention that what the GFRP framework recommended in 2008 relative to what was recommended post-2008 is in a certain way justifiable as a short-term measure given that all in all, trade policies may be an effective instrument for short-term price stabilization purposes in some nations: those facing considerable political unrest, lacking adequate food distribution networks, with no safety nets available, etc. However, they may have important beggar-thy-neighbor consequences and may fuel price increases of important commodities. The 2007/08 food crisis—especially in the case of rice—is quite illustrative in this respect. Insulating trade policies imposed by importers and exporters (as well as high-income and developing countries) were indeed responsible for a considerable share of price spikes. However, even when the aggregate effect of the actions of these broad groups is quite large, most of the turmoil was likely caused by large exporters and importers. In this sense, if the argument is that such policies create further imbalances for others, policy recommendations should distinguish between larger and smaller countries; from all the countries where we see these inconsistencies, the Philippines is the only one falling into the category of a significant importer of rice where the World Bank should be clearly against import tenders and quantitative restrictions, given they clearly helped to exacerbate international prices in the rice market.

With respect to food reserves, the discussion seems to highlight the need for food reserves to ease the effect of shocks during periods of commodity price spikes and volatility. There seems to be some consensus around this idea. The disagreement stems from the specific mechanisms to implement food reserves. As in the case of trade interventions, the most appropriate choices are likely to depend on the characteristics of the specific market under intervention, the country's capacity to cope with crises, and the possibility of establishing international coordination mechanisms. While it likely does not make sense to establish national buffer stocks in most grain markets, it may be more valid in a few cases, such as in the rice market. Again, however, regional reserves with strong governance and clear triggers

are preferred. However, it is important to mention that the GFRP framework is not extremely clear on this in difference to what was recommended post-2008. It is in that sense that when analyzing the operational plans of the GFRPs, proposals can be identified that promote country-level reserves as buffer stocks, as in the case of: (a) Bangladesh where the stocks were increased from 1 to 1.5 million MT of rice, (b) the NFAs in Philippines, and (c) the NFAs in Guinea. It could also be argued that these reserves were consistent with the official position of the World Bank through the GFRP framework, although clearly these types of policies are problematic in countries where the necessary conditions for these reserves to work don't exist. Additionally, buffer stocks usually entail high costs and market distortions and are prone to corruption. Thus, most countries—especially those with weak institutions and scarce resources—should probably refrain from using buffer stocks.

Finally, with respect to the medium- and long-term policies, we see significant investment in the GFRPs (e.g., the provision of infrastructure and public goods in Mozambique, increasing seed availability in Mali, and the rice intensification program in Madagascar). In addition, and as recommended in the GFRP framework document, we also see the important presence of input subsidies similar to those that have failed in Malawi with a fiscal cost of around 3 % of the GDP. These plans envisage the implementation of a market-smart approach to input subsidies. Such a strategy is characterized by: (a) targeting poor farmers; (b) not displacing existing commercial sales; (c) utilizing vouchers, matching grants, or other instruments to strengthen private distribution systems; and (d) being introduced for a limited period of time only. Albeit outlining a sensible rationale, it is unclear how these principles would be implemented in practice in poor countries like in the GFRPs in Haiti, Cambodia, Mali, Sierra Leone, and Rwanda. Poorer countries—which likely have the least developed input markets—may find it difficult to target only those farmers in need. Additionally, subsidy programs that would strengthen, rather than displace, the private sector are likely to require complex mechanisms. Institutional weaknesses of poor countries may render them unfeasible, aside from the fiscal costs.

It is important to note that in many countries, input markets are not well developed, as they are hampered by various policy, institutional, and infrastructure constraints that can only be overcome over time, while improvement in access to inputs would provide substantial benefits in the short run, given the crisis circumstances. It is in that sense that the "smart subsidies" proposed under the GFRP framework could be conceptually justifiable even though as a short-term measure they can also create fiscal problems as previously mentioned based on the Malawi experience. Moreover, it is of central importance that any "smart subsidy" policy includes the five key characteristics mentioned in the previous paragraph. Furthermore, a long-time horizon is required to apply the "first-best" policies, namely, the alleviation of constraints (such as infrastructure and missing credit markets) which inhibit the development of efficient input markets.

Therefore, although this "second best measure" in the face of existing constraints as stated in the GFRP framework document could be justifiable in the short term the key is to assure all other needed elements are in place for its success; specifically,

it has to be guaranteed that investments to alleviate the key constraints of the input market are also started at the same time. All of these arguments are conceptually valid, although their applicability in any given country cannot be taken for granted; in most cases, applicability was not actually and explicitly verified in the assistance programs funded under GFRP, and the key four characteristics of the proposed "smart subsidies" strategies were not validated in advance.

In summary, when assessing the consistency of the specific loans and policies prescribed officially by the World Bank for selected countries during the 2007/08 food crisis, we identify that (given the significant flexibility of the World Bank official recommendations) most of the loans comply with what was proposed in the GFRP framework. However, when analyzing the consistency of those recommendations to the research results published by the World Bank post-2008, we found significant inconsistencies, especially in short-term policies. As a result, it is extremely important for the World Bank to carefully assess the risks and costs of the implementation of the official, more flexible, recommendations of the GFRP against what is currently being advocated at the Bank and to carefully assess how to avoid these inconsistencies in the future.

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Part V

The Micro-Economics of Price Risk, Volatility and Price Shocks: Households, Firms and Communities