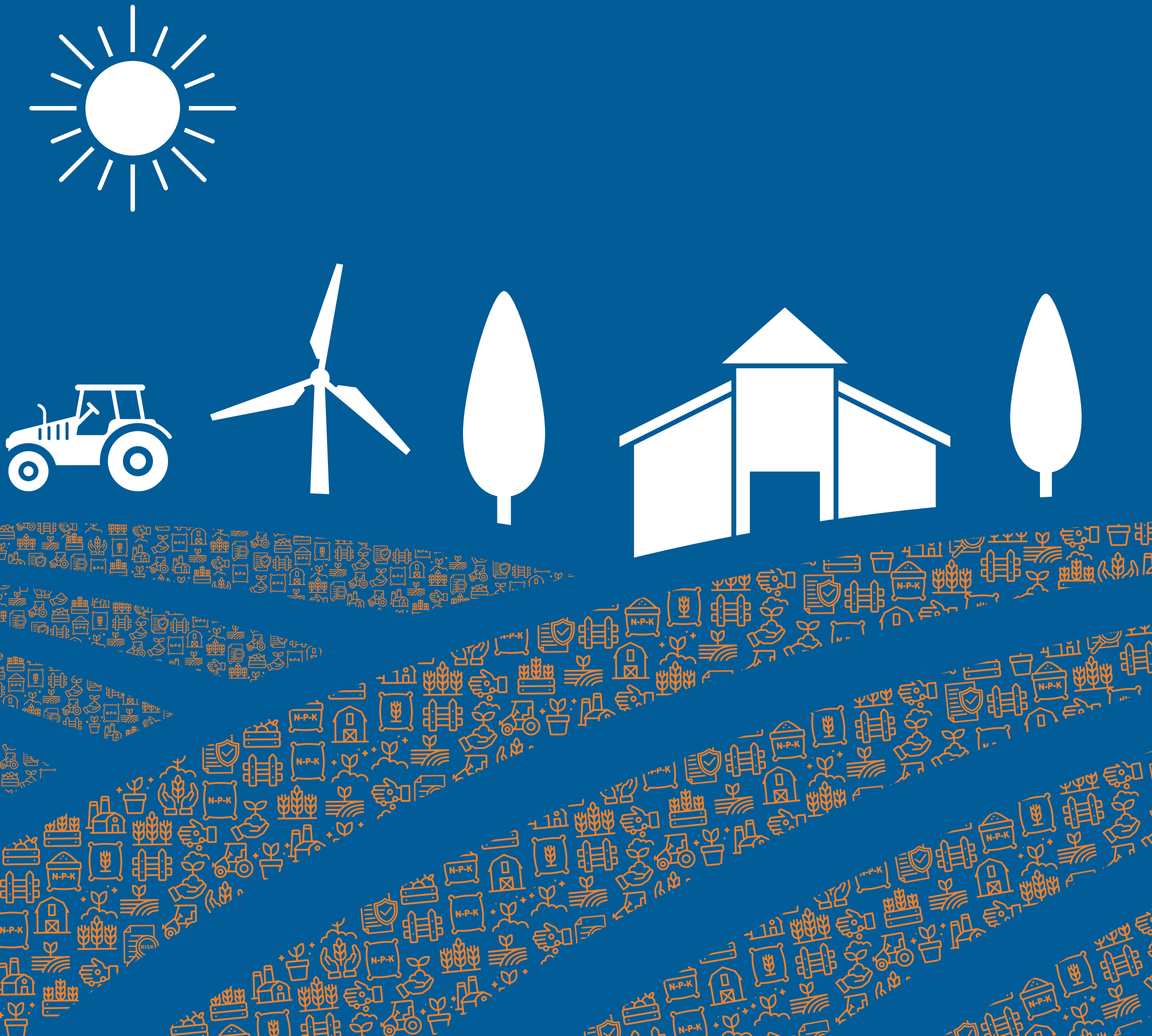
ESSAYS ON

RISK, INSURANCE AND WELFARE

OCCASIONAL PAPER NO. 219



Export-Import Bank of India

Occasional Paper No. 219

ESSAYS ON RISK, INSURANCE AND WELFARE

This study is based on the doctoral dissertation titled "Essays on Risk, Insurance and Welfare", which is selected as the winning entry for the Export-Import Bank of India's BRICS Economic Research Annual Citation (BRICS Citation) 2023. The dissertation was written by Dr. Digvijay Singh Negi, currently Fulbright-Nehru Postdoctoral Fellow, Cornell University, USA, under the supervision of Professor Bharat Ramaswami (Indian Statistical Institute), with whom the first two chapters of this study are co-authored. Dr. Negi received his doctoral degree in 2018 from the Indian Statistical Institute.

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EXECUTIVE SUMMARY

This study constitutes a collection of three independent chapters that assess the role of international trade and formal insurance markets in insulating countries and producers from production shocks. It also examines the distributional implications of rising prices on net producers and consumers of food commodities.

The sharp surge in global food prices in recent years has led to concerns about the functioning of global food markets. In general, global food production is more stable than regional or national production, and thus free trade should be able to achieve greater stability in prices and consumption. The primary objective of the first chapter is to examine the performance of world markets for grains (maize, rice, and wheat) in a risk sharing framework. This chapter adopts the predictions of the efficient risk-sharing hypothesis as a benchmark. A necessary condition for efficient risk sharing is that food consumption should be perfectly correlated with global production and independent of domestic production. The chapter finds that the efficient risk-sharing hypothesis is rejected for the global food markets. However, the global wheat market is closest to the efficient risk-sharing allocation. Trade across countries plays an important role in insulating consumption from production fluctuations in all three commodities. Further, higher-income countries show greater food consumption insurance than middle and lower-income countries.

Agriculture and agriculture-based livelihoods in developing countries are highly prone to weather shocks. Even though farmers in developing countries are typically poor and even though they bear the burden of volatile income streams, formal insurance products have had limited success. The difficulties of administering the first best insurance programs tailored to the production histories of individual farmers have led to index insurance products where payouts are triggered by an index such as rainfall, temperature, or local average yields. Setting premiums is relatively easier because past data on indices of weather and average yield are more readily available than on individual production histories. As individual farmers have little or no influence on payouts, index-based insurance products are also less likely to fail due to asymmetry in information between the insurer and the insured. Despite the promise of index insurance, the record is mixed. In particular, the uptake of index insurance is poor, especially when it is not subsidized.

The second chapter examines how rainfall insurance contracts in India can be designed to reduce basis risk. The study finds that the associations between yield losses and index losses are stronger for large deviations than for small deviations. The major implication is that the value (to farmers) of index-based insurance relative to actuarial cost is highest for insurance against extreme or catastrophic losses (of the index) than for insurance against all losses. Or, basis risk is the least for large deviations of the index. The goal of this chapter is to test this hypothesis. We find that station-level rainfall in India does exhibit tail-dependence and the joint distribution of district-level crop yields for nine major crops and rainfall index also exhibit tail-dependence. This implies that value to a risk-averse farmer of index-based insurance relative to actuarial cost is highest for insurance against extreme or catastrophic losses (of the index) than for insurance against all losses. Because of tail dependence, the demand for commercially priced rainfall insurance is more likely to be positive when coverage is restricted to extreme losses.

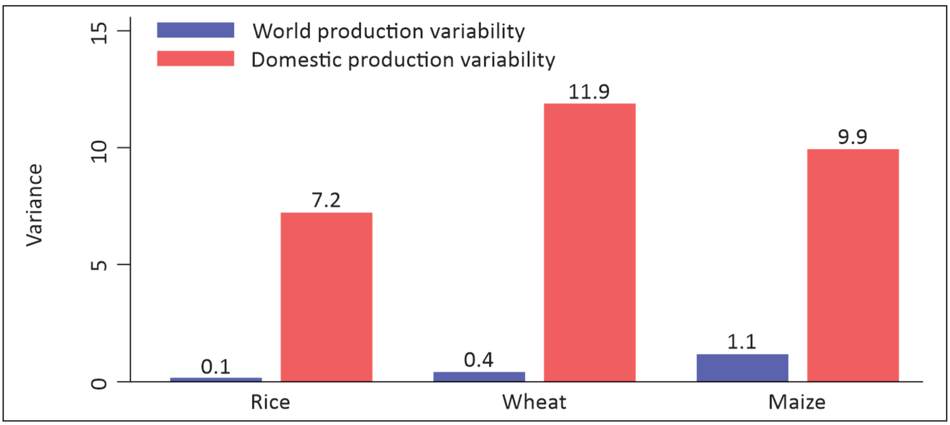
There is much debate on the impacts of high food prices on household welfare in developing countries. Since food is a necessity, the welfare effects of high food prices would be experienced universally. The major cause of concern is that as exposure to high food prices is proportional to its budget share in household expenditure, the worst affected population groups would be ones placed at the bottom of the income distribution. Therefore, rising food prices have become a matter of serious concern for developing countries, which are home to a majority of the world's poor.

The third chapter studies the impact of high global rice and wheat prices on household welfare in India. The chapter uses the 2007-08 surge in global food prices to show that rice and wheat cultivating households gain from high prices. These welfare gains mainly accrue to net producers. It is observed that net producer households were able to maintain their per capita spending and consumption of rice and wheat by decreasing consumption of market purchased rice and wheat and increasing consumption of government-subsidized rice and wheat. Net consumers, on the other hand, experienced a decline in the total per capita consumption of rice and wheat even though they substituted their market purchases with homegrown produce and subsidized grains. The role of in-kind food transfers in insulating households from high prices was evident for both net producers and consumers.

1. INTERNATIONAL RISK SHARING FOR FOOD STAPLES

World production of food staples is very stable. The variance of production shocks (measured as the difference in log values of production over successive time periods) is 0.1 for rice, 0.4 for wheat, and 1.1 for maize. On the other hand, production at a country level is highly variable. Figure 1.1 compares the variance of global shocks with the variance of individual country output (averaged over 100 countries). Despite the country-level instability, individual countries should be able to achieve stability in consumption of about the same order as that of world production through trade. Indeed, the stability of world food aggregates has frequently led economists to advocate international trade as an effective mechanism for price and, therefore, consumption stabilization.

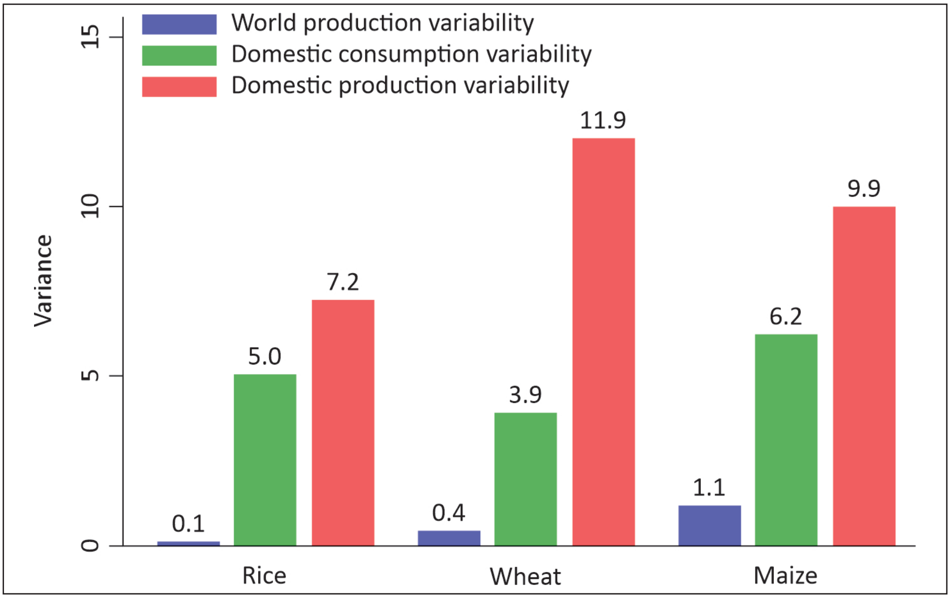
Figure 1.1: Production variability of Rice, Wheat, and Maize: 1961-2013



Note: Authors' estimates based on the food balance sheet data from the Food and Agriculture Organization's (FAO) database.

Figure 1.2 adds the variability of individual country consumption to the global and individual country production variability plotted in Figure 1.1. It can be seen that while, on average, individual country staple food consumption variability is lower than production variability, it is, however, many magnitudes higher than the global variability in food production. Figure 1.2 suggests, that while there is some consumption smoothing, global food markets fall well short of the risk-sharing ideal.

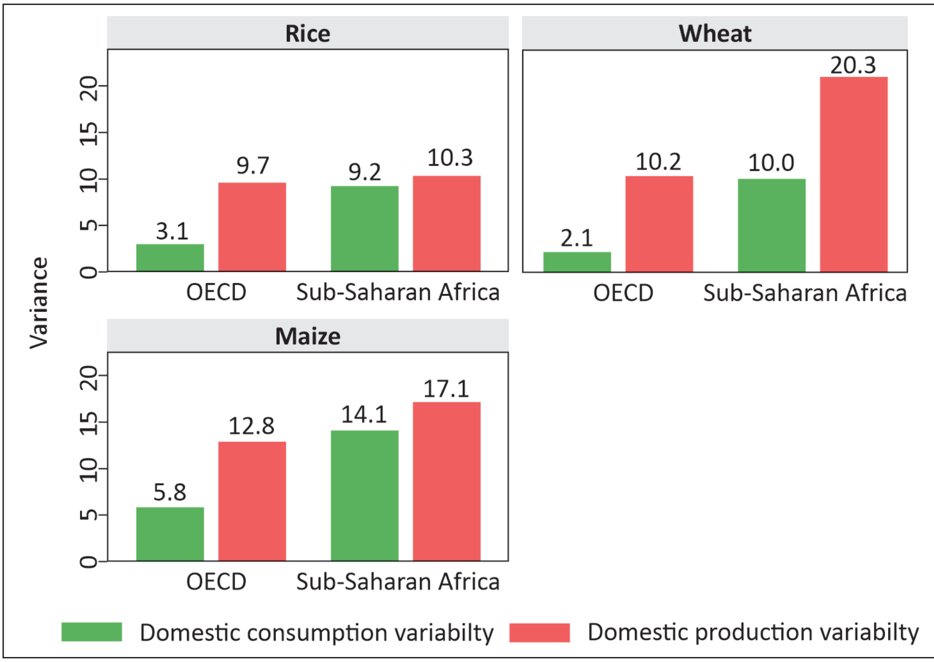
Figure 1.2: Production and Consumption Variability of Rice, Wheat and Maize: 1961-2013



Note: Authors' estimates based on the food balance sheet data from the Food and Agriculture Organization's (FAO) database.

Figure 1.2 also points to heterogeneity across commodities. Despite, higher production variability, wheat markets seem to achieve greater risk sharing than the other staples. Figure 1.3 illustrates heterogeneity across another dimension: income. The gap between consumption variability and domestic production variability is much more pronounced for OECD countries than for countries in Sub-Saharan Africa. It is only in the case of wheat that African countries display substantial consumption smoothing.

Figure 1.3: Production and Consumption Variability between OECD and Sub-Saharan Africa: 1961-2013



Note: Authors' estimates based on the food balance sheet data from the Food and Agriculture Organization's (FAO) database.

Figures 1.2 and 1.3 are the motivation for this chapter. First, it formally tests for risk sharing in the markets for maize, rice, and wheat. Second, the chapter estimates the extent of risk sharing and the contribution of trade and storage to it. The analysis is conducted separately for each of the staples to allow for heterogeneity across markets. Third, the chapter examines whether consumption smoothing is different for rich and poor countries. Maize, rice, and wheat account for 50 percent of the dietary energy supply and 20-25 percent of total expenditures for people in the bottom quintile of the income distribution (Dawe et al., 2015). Arguably, variability in this component of consumption is expensive for the poor. It is, natural, therefore, to examine risk sharing in the markets for these staples.

There is a large literature on the functioning of world markets for basic staples. Two components of this literature are particularly relevant to this chapter. The first strand examines the transmission of prices from global markets to domestic markets. Typically, the finding is that the transmission is imperfect because of trade barriers. In the second and related literature, trade barriers are seen as instances of ‘market insulating’ behavior. Countries use trade policies to insulate their domestic markets from price volatility in the global market. During price spikes, the use of trade-restrictive policies is common, and when all countries attempt to insulate their domestic markets simultaneously, these render global food markets extremely thin and can magnify volatility in global food prices.

The contribution of this chapter to the food markets literature is severalfold. First, although a lack of risk sharing is implicit in past literature, this is the first work to study and quantify it. Second, the focus on consumption variability directs attention to the variable that matters in economic models. Thin world markets and imperfect price transmission make it awkward to study price variability. Third, the chapter provides a common metric to assess the relative performance of the markets for maize, rice and wheat. Fourth, the methodology allows to address the consumption smoothing of poor countries vis-á-vis rich countries.

The study is also related to consumption risk sharing that has been analyzed for macro aggregates (regions, countries). A principal difference is that the macro literature considers consumption aggregates in value terms while it is both natural and feasible to measure food consumption and production in physical units. In that sense, the application in this chapter is tethered more closely to the theory of risk sharing than the macro literature. As the preliminary evidence (for instance, Figure 1.3) suggests heterogeneity in risk sharing, the formal empirics pay a great deal of attention to unobserved heterogeneity in the coefficients of idiosyncratic and aggregate shocks.

1.1 Literature

Trade and storage are two principal means by which countries have sought to align unstable output with the need to smooth consumption. However, public stocks are considered to be a costly option, as they tie up scarce resources, are vulnerable to deterioration, corruption, and theft; and may crowd out the private sector from holding food stocks (Gilbert, 2011). Knudsen and Nash (1990), from a review of experiences on domestic price stabilization programs across the world, concluded that stabilization schemes should “avoid handling the commodity when possible”.

On the other hand, several studies have indicated that in comparison to public stock holdings, international trade is an economical means of stabilizing food supplies (Valdes, 1981; Krishna et al., 1983; Dorosh, 2001). The idea that trade can stabilize consumption has long been recognized in the literature. Timmer (2008) argued for a move away from national food security stocks towards food security via trade and production based on comparative advantage.

In general, global food production is more stable than regional or national production, and thus free trade should be able to achieve greater stability in prices and consumption. In the words of Gilbert (2011), “If supply (harvest) shocks are largely uncorrelated across countries, governments can import when they need to do so without, on average paying high prices”. The caveat introduced by Gilbert acknowledges that the contribution of trade would depend on the correlation of production shocks across countries.

The recommendation that trade (along with targeted safety nets) ought to be a principal component of food security policy is part of the policy paradigm advocated by economists (Gouel, 2013). In practice, many countries have rejected the paradigm. Studies have found the transmission of world price shocks to domestic prices to be generally limited (Baquedano and Liefert, 2014; Ceballos et al., 2017; Dawe et al., 2015; De Janvry and Sadoulet, 2010; Gilbert, 2011; Minot, 2011; Mundlak and Larson, 1992; Robles et al., 2010).

A possible explanation is suggested by a parallel literature, according to which, countries use trade policies to insulate their domestic markets from price volatility in the global market. During price spikes, countries attempt to maximize their share of the global market. Exporting countries restrict exports while importing countries drop tariffs. The opposite happens when there are surpluses. When all countries attempt to insulate their domestic markets simultaneously, these render global food markets extremely thin and can magnify volatility in global food prices (Abbott, 2011; Martin and Anderson, 2011; Giordani et al., 2016; Gilbert and Morgan, 2010; Mitra and Josling, 2009; Headey, 2011; Slayton, 2009). A typical instance that has been cited widely is the behavior of rice markets during 2007/08. It is believed that government actions of panic buying (by importers) and export prohibitions (by exporters) contributed to price spikes (Dawe and Slayton, 2011; Timmer, 2008; Wright, 2011). The unreliability in world food markets, when needed most, would lead to serious doubts on their efficiency in providing insurance against adverse production shocks.

Although the literature assigns risk sharing to be the primary contribution of international trade to food security, this has not been tested or quantified in the literature. This is the point of departure for this chapter. The chapter explicitly formulates the risk-sharing hypothesis and takes it to data examining the contribution of trade and storage. While the literature documents low price transmission and market insulating behavior, Figure 1.2 shows that countries do achieve some consumption smoothing relative to the variability in their production. How much of it is because of trade? Or is it because of storage? These are the questions that can be asked within a risk-sharing framework.

This chapter is most closely related to the literature on international consumption risk sharing that has sought to examine whether national aggregate consumption is fully insured against national risks. Most studies find that consumption risk sharing, even within developed countries, falls well short of the optimal benchmark (Canova and Ravn, 1996; Crucini, 1999; Lewis, 1996). This literature has been extended in several ways. Kose et al. (2009) apply the risk-sharing framework to a large group of developed and developing countries to contrast risk-sharing across these groups and to examine the effects of financial globalization. Other studies have examined intra-national risk sharing (between states or provinces) or national risk sharing within monetary unions (Asdrubali et al., 1996; Sørensen and Yosha, 1998).

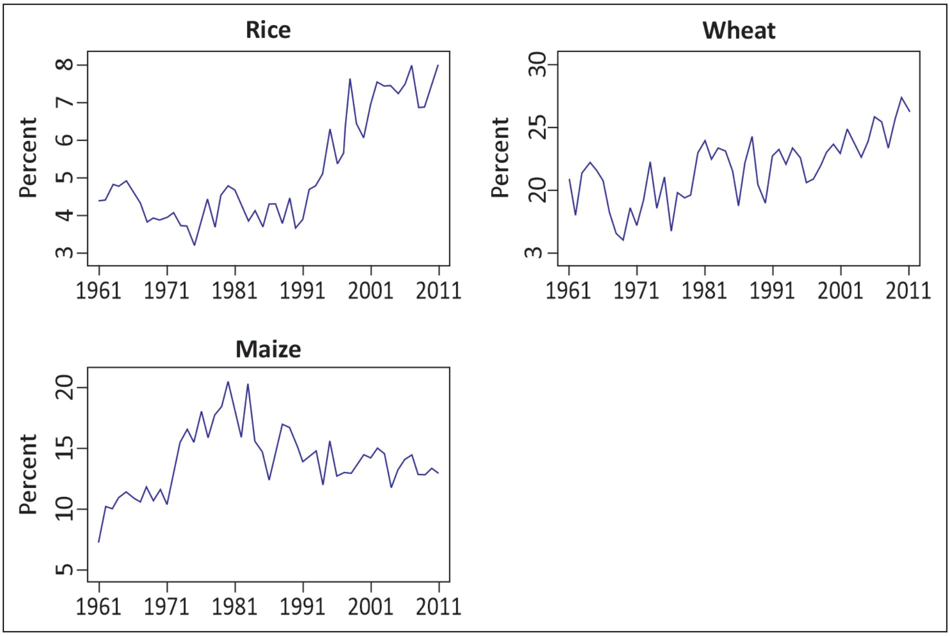
This chapter extends the risk-sharing framework to food staple markets. Unlike the literature which considers risk sharing in a composite commodity (e.g., GDP or household consumption), the staples here can be aggregated in physical units whether for consumption or for production shocks. While that is the advantage of considering individual commodities, the empirical challenge is to address the non-separability in preferences across commodities that naturally arise when endowments are multi-good. In addition, these preferences may vary across countries. These complications may lead to unobserved heterogeneity in the impact of both aggregate and idiosyncratic shocks. Besides addressing these challenges, the chapter also investigates how heterogeneity in risk sharing relates to observable characteristics such as country per capita income.

1.2 Data and Correlations

The Food and Agriculture Organization's (FAO) `Food Balance Sheets' dataset (FAOSTAT, 2014) provides country-level time series (1961-2013) for output, domestic supply, food consumption, stock variations, and trade of major agricultural commodities. We focus on three important staple food commodities: rice, wheat, and maize. Our consumption measure includes food, feed, and other uses. We calculate consumption as follows: Consumption = Output + Imports − Exports - Stock Variation.

We convert the consumption and output quantities into per capita terms using the population figures from the World Bank World Development Indicators (WDI) database. We take logs and first differences of per capita consumption and output to get year-on-year growth rates. To guard against the possibility that small countries may drive the results, we weight our summary statistics and regressions, using population shares as weights, since they are highly correlated with consumption shares, and since population is not directly used in the regressions other than to normalize consumption and output.

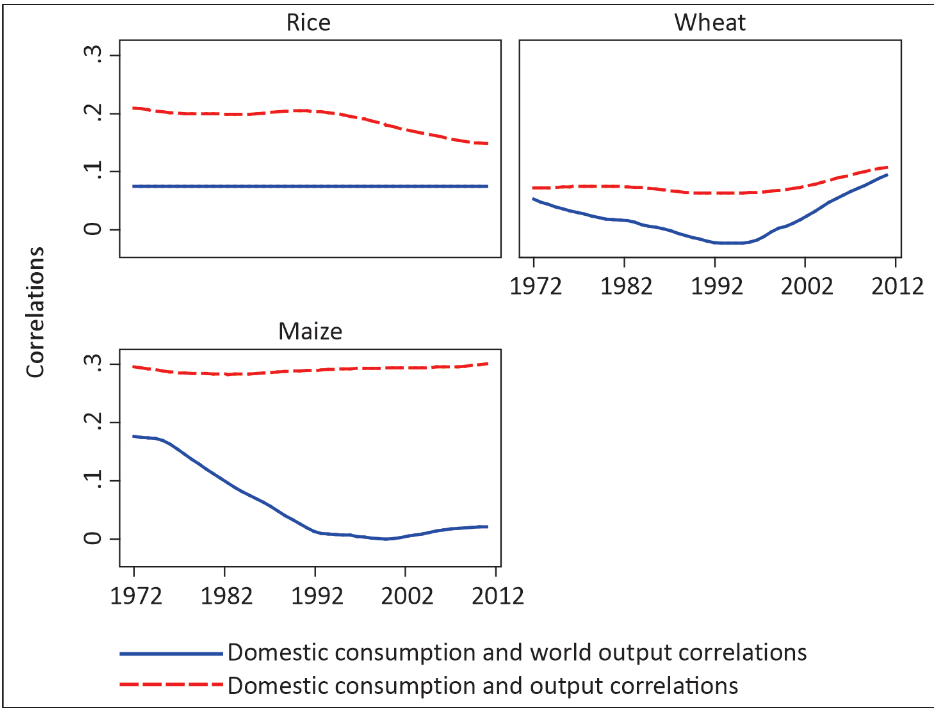
Figure 1.4: Trends in World Exports as a Share of World Production: 1961-2013



Note: Authors' estimates based on the food balance sheet data from the Food and Agriculture Organization's (FAO) database.

Figure 1.4 plots the trends in trade of rice, wheat, and maize as a proportion of their outputs. The volume of rice trade was almost stagnant until the 1990s when it started showing a significant rising trend. Export liberalization in India in 1993 and the rise of Vietnam as a major rice exporter drove this increase (Jha et al., 2016). Wheat trade volume varies a lot with no visible trend. Maize trade increased in the 1970s and peaked in 1980 before showing a declining trend. Over the period, 1961-2013, wheat is the most traded commodity, with about 18% of output traded on average, followed by maize at 12% and rice at 4%. This suggests that consumption risk sharing is likely the greatest for wheat markets.

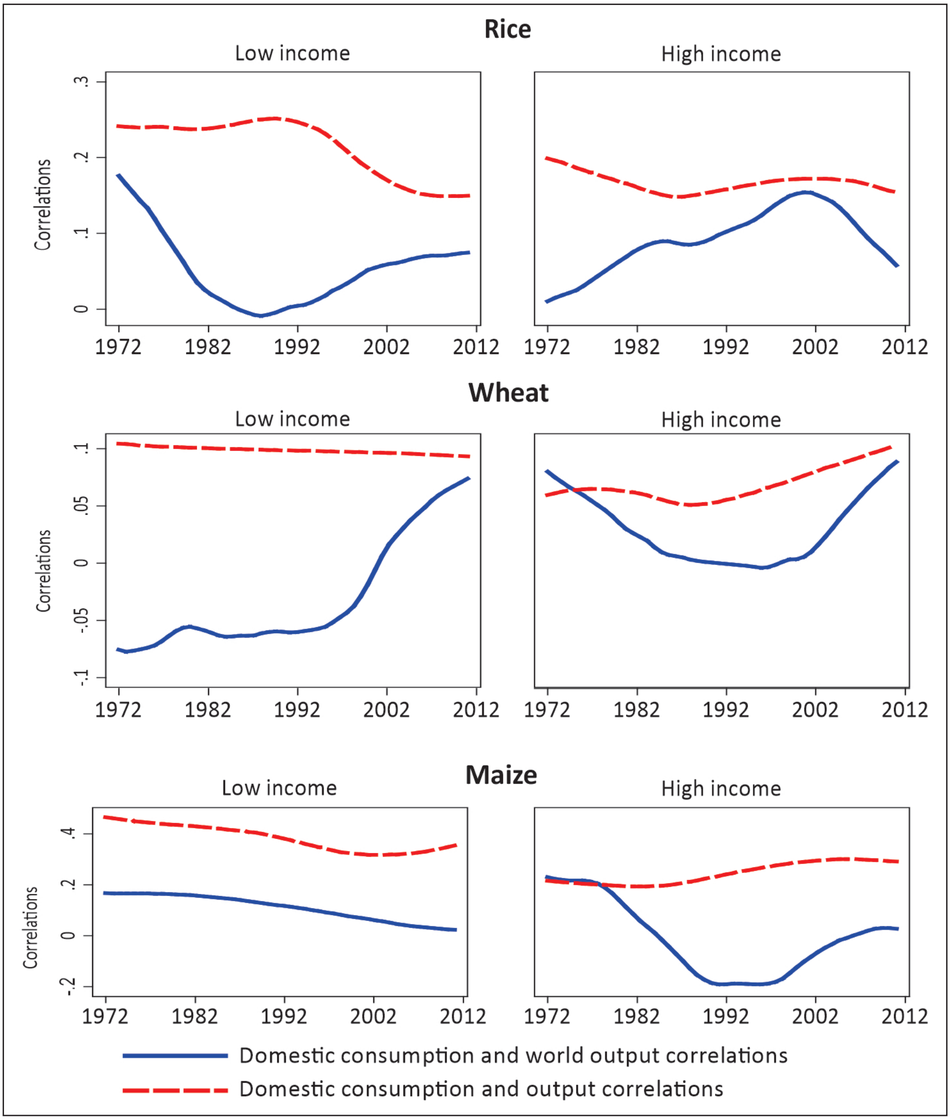
Figure 1.5: Average 10 Year Rolling Correlations: 1961-2013



Notes: Authors' estimates based on the food balance sheet data from the Food and Agriculture Organization's (FAO) database. Moving average correlations were calculated for each country. The figures plot the non-parametrically fitted regression line to country level moving average correlations.

As a step towards testing the predictions of the efficient risk sharing hypothesis, we examine the correlation of the growth in domestic consumption with the growth in domestic output and with the growth in world output for rice, wheat, and maize. Figure 1.5 summarizes these correlations. The solid lines show the trend in the median decadal moving average correlations of domestic consumption and world output growth, and the dashed lines show the trend in the corresponding correlations of domestic consumption with domestic output. The estimated correlation coefficients between domestic consumption and world output are well below unity, while domestic consumption is correlated with domestic output for the entire period. The first result indicates that markets are not fully open, and the second that risk sharing is imperfect.

Figure 1.6: Average 10 Year Rolling Correlations by Income: 1961-2013



Notes: Authors' estimates based on the food balance sheet data from the Food and Agriculture Organization's (FAO) database. Moving average correlations were calculated for each country. The figures plot the non-parametrically fitted regression line to country level moving average correlations. Low and high income countries are based on the classification followed by the World Bank. The world bank classification of income groups used is time-invariant and corresponds to the year 2014.

These correlations by national income levels are broken down. Following the World Bank classification, four groups: low income, lower middle income, upper middle income, and high income are considered. For the sake of brevity, Figure 1.6 displays these results only for low- and high-income countries. For all three goods, poor countries have slightly higher correlations between domestic consumption and output growth (red dotted lines), implying lower risk sharing. The domestic consumption and world output correlations (blue solid lines) have dropped over time in poorer countries for rice and maize, indicating diminishing international integration, with an especially steep initial drop in rice and a small recovery thereafter. For rich countries though, the correlations do not show much of a trend.

1.3 Results

Based on the optimal risk sharing hypothesis, tests of risk sharing regress growth rate of per capita country consumption on an aggregate shock and growth of per capita country production. The basic regression specification is as below:

$$c_{it} = \alpha_i + \mu_t + \gamma y_{it} + \varepsilon_{it} \tag{1.1}$$

where c and y denote the growth rates of per capita consumption and production respectively for country i at time t, α_i is a dummy variable for country i and μ_t is a time dummy that measures aggregate shock. Under full risk sharing, after controlling for aggregate shocks, consumption should be independent of idiosyncratic shocks, thus the optimal risk sharing hypothesis is $\gamma = 0$.

Rejection of the hypothesis implies that countries are not able to fully insure themselves from idiosyncratic supply shocks, hence consumption will be correlated with production. In that case, $(1 - \gamma)$ can be interpreted as a measure of the degree of insurance or risk sharing achieved (Asdrubali et al., 1996; Crucini, 1999). Several studies (Asdrubali et al., 1996; Kose et al., 2009) have conducted tests of risk sharing based on a version of the specification in equation (1.1). The idea is that time dummies will remove the common component in both the consumption and production growth and therefore

γ can be interpreted as the effect of idiosyncratic production growth on idiosyncratic consumption growth.

(i) Benchmark estimates

The first column of Table 1.1 shows the results of regressing consumption growth on domestic output growth (y_{it}) without nation and time dummies for each of the three food staples. The second column adds the country dummies, while the third column—the preferred specification—includes time dummies as well. The addition of time dummies in the third specification leads to a minor increase in R^2 but leaves the coefficient unchanged. These results are robust across specifications. The fourth column omits time dummies and instead adds the growth rate of global consumption as a control for aggregate shocks. The estimates are robust to this specification as well.

Table 1.1: Test of Risk Sharing

	(1)	(2)	(3)	(4)
Dependent variable: per capita consumption growth				
(a) Rice				
y_{it}	0.255***	0.251***	0.249***	0.250***
	(0.032)	(0.031)	(0.031)	(0.031)
$\bar{c}_t$				0.219**
				(0.105)
Country dummies	No	Yes	Yes	Yes
Time dummies	No	No	Yes	No
N	5018	5018	5018	5018
R-squared	0.133	0.145	0.167	0.147
F-statistic	64.896	63.984	63.232	39.390
(b) Wheat				
y_{it}	0.118***	0.117***	0.117***	0.118***
	(0.023)	(0.023)	(0.022)	(0.023)
$\bar{c}_t$				0.682***
				(0.164)

	(1)	(2)	(3)	(4)
Country dummies	No	Yes	Yes	Yes
Time dummies	No	No	Yes	No
N	4753	4753	4753	4753
R-squared	0.039	0.046	0.105	0.062
F-statistic	25.426	25.682	28.119	19.616
(c) Maize				
y_{it}	0.333***	0.336***	0.324***	0.333***
	(0.062)	(0.062)	(0.049)	(0.062)
$\bar{c}_t$				0.451***
				(0.101)
Country dummies	No	Yes	Yes	Yes
Time dummies	No	No	Yes	No
N	6342	6342	6342	6342
R-squared	0.169	0.184	0.219	0.190
F-statistic	28.500	29.215	42.797	53.502

*Notes: Variable denotes the per capita output growth rate and denotes the cross sectional average of per capita consumption growth. All regressions are weighted by the country's average share of the world population. Figures in parentheses are standard errors robust to heteroscedasticity and within country serial correlation. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.*

The correlations between consumption and production growth differ significantly from zero for the three grains, rejecting the optimal risk-sharing hypothesis. These results reinforce our earlier observation that countries seem unable to insulate domestic consumption from idiosyncratic output shocks. Comparing the degree of risk sharing across food markets in Table1.1, the wheat market performs best, providing 88% (1-0.12) insurance against domestic output shocks, compared to 75% (0.25) for rice and 67% (1-0.33) for maize.

Table 1.2: Risk Sharing for Large and Small Consumers and Producers

	(1)	(2)	(3)	(4)
	Consumption share		Output share	
	≥ 5%	< 5%	≥ 5%	< 5%
	Large countries	Small countries	Large countries	Small countries
Dependent variable: per capita consumption growth				
(a) Rice				
y_{it}	0.244***	0.211***	0.244***	0.211***
	(0.033)	(0.027)	(0.033)	(0.027)
$\bar{c}_t$	-0.136	0.613***	-0.136	0.613***
	(0.112)	(0.165)	(0.112)	(0.165)
N	208	4810	208	4810
R-squared	0.229	0.112	0.229	0.112
F-statistic	26.949	37.385	26.949	37.385
(b) Wheat				
y_{it}	0.188***	0.072***	0.186***	0.072***
	(0.046)	(0.014)	(0.038)	(0.014)
$\bar{c}_t$	0.601**	0.634***	0.488**	0.640***
	(0.259)	(0.126)	(0.220)	(0.128)
N	184	4569	234	4519
R-squared	0.111	0.045	0.114	0.045
F-statistic	10.407	21.789	13.909	21.603
(c) Maize				
y_{it}	0.370***	0.223***	0.370***	0.223***
	(0.031)	(0.036)	(0.031)	(0.036)
$\bar{c}_t$	0.106	0.689***	0.106	0.689***
	(0.152)	(0.122)	(0.152)	(0.122)
N	154	6188	154	6188
R-squared	0.504	0.121	0.504	0.121
F-statistic	73.767	39.186	73.767	39.186

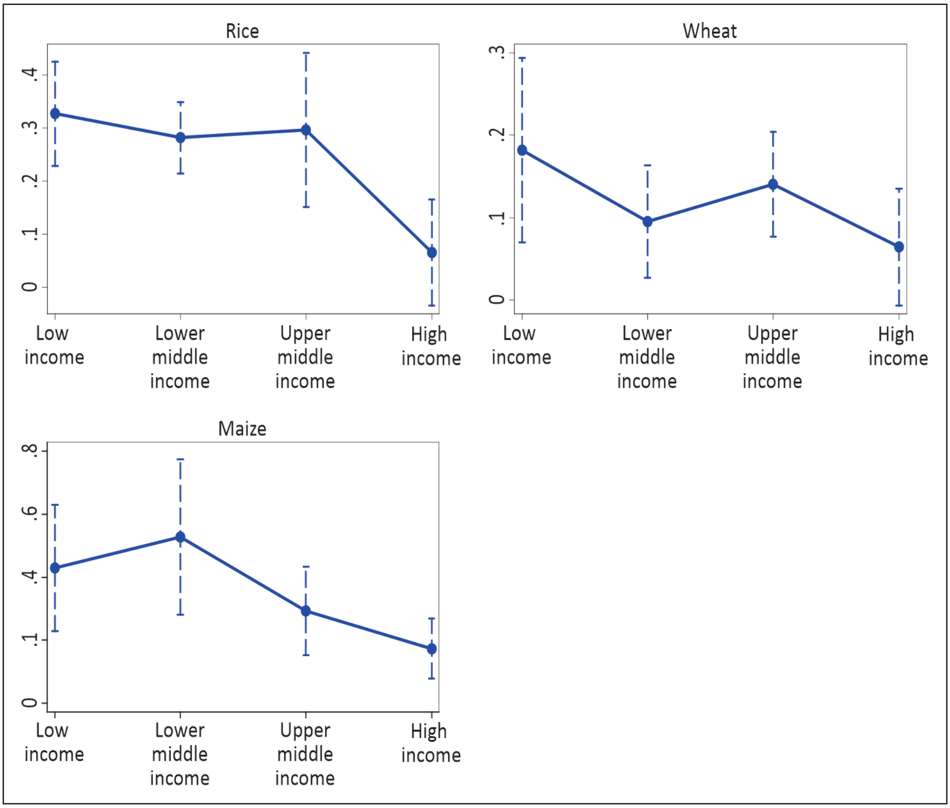
*Notes: Variable denotes the per capita output growth rate and denotes the cross sectional average of per capita consumption growth. For both consumption and output, rice large countries are Bangladesh, China, India, and Indonesia; wheat large countries are China, India, Russia, and USA; and maize large countries are Brazil, China, and USA. In addition, France is a large wheat producer. All other countries are taken as small consumer/producer countries. All regressions include country fixed effects and are unweighted. The correlation between average consumption and output shares across countries for rice, wheat and maize are 0.88, 0.73 and 0.90. Figures in parentheses are standard errors robust to heteroscedasticity and within-country serial correlation. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.*

Table 1.2 presents the estimates of the degree of risk sharing for large and small consumers and producers of the three commodities separately. We define large consumer or producer countries as those whose consumption or output exceeds 5% of the world's total. Table 1.2 shows large consumers and producers share risk less than small ones. Thus, both large consumers and large producers rely less on international food markets for consumption smoothing. In theory, large consuming countries should share risk as much as small ones. As noted in Table 1.2, though, large consumers are also large producers, which are more likely to engage in market insulating policies and thus less likely to risk share.

(ii) Heterogeneity in risk sharing by income

As observed in Figure 1.6, risk sharing could vary with per capita income. Low-income countries have the lowest degree of risk sharing (lower risk sharing corresponds to a higher correlation between consumption and production in the figure), which rises with income. For example, rice consumption in low-income countries is insured against only 38% of the shocks to output, while domestic consumption is almost completely insured from output shocks in high-income countries. Wheat has a similar situation. For maize, high-income countries fall short of complete insurance but come close. The difference in the degree of risk sharing between low- and high-income countries for all three goods is statistically significant. We also observe that risk sharing improves over time in low-income countries for all three commodities, more so for rice and maize.

Figure 1.7: Risk Sharing and Income



Notes: The figure displays the estimated γ's, along with 95% interval estimates, for low income, lower middle income, upper middle income, and high income countries. The average marginal effects have been estimated for the year 1987, which is the midpoint of the time period in our dataset. Country groups are based on the classification followed by the World Bank. The world bank classification of income groups used is time-invariant and corresponds to the year 2014.

(iii) Relative contributions of trade and storage

Table 1.3 reports the results. In the case of wheat, trade contributes more to risk sharing than storage. For rice, domestic stocks play the dominant role. For maize, trade and domestic stocks contribute about equally to risk sharing. Of the risk sharing that is achieved, trade is responsible for 35% in rice, 60% in wheat, and 53% in maize.

Table 1.3: Contribution of Trade and Storage in Risk Sharing

	(1)	(2)	(3)
	Trade	**Storage**	**Residual**
Rice	0.263***	0.488***	0.249***
	(0.078)	(0.067)	(0.031)
Wheat	0.532***	0.350***	0.117***
	(0.070)	(0.062)	(0.022)
Maize	0.358***	0.319***	0.324***
	(0.076)	(0.063)	(0.050)

*Notes: Figures in parentheses are standard errors robust to heteroscedasticity and within-country serial correlation. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.*

In absolute terms, it is found that trade contributes more to smoothing domestic output shocks in wheat (53%) than in maize (36%) and rice (26%). We expect this, as wheat is one of the most traded food commodities in the global market and has fewer trade distortions than rice. In the case of maize, insurance through trade is lower than for wheat and closer to rice. This is contrary to expectation as the total volume of maize exports far exceeds that for rice. The different varieties of maize traded could help to explain this. Dawe et al. (2015) study the price behavior of staple food commodities in low- and middle-income countries and find that domestic maize prices are more volatile than rice and wheat prices, because of the thin global market for white maize, which is mostly used for human consumption, especially in sub-Saharan Africa. (Maize in sub-Saharan Africa accounts for 30-50% of total household consumption expenditure.)

1.4 Conclusion

Greater stability in the growth of global food output than in national or regional output theoretically implies tremendous potential for trade to enable risk sharing across countries. No previous study, though, has formally tested for risk sharing in world food markets. The present chapter fills this gap in the literature by using the efficient risk-sharing hypothesis as a benchmark to examine the extent to which trade insulates domestic consumption against domestic output shocks. This is done after suitably extending the existing theoretical and econometric methods to account for trade costs. The importance of trade relative to storage in risk sharing is also compared.

The rejection of the efficient risk-sharing hypothesis likely does not surprise observers of world food markets. The superior performance of the wheat market in providing insurance also matches expectations. The finding, though, that the maize market performs just as poorly as the rice market is unexpected. One possible reason is that these markets have significant product differentiation, making it harder for the market to provide insurance. Another noteworthy finding is that both trade and storage provide insurance for all three markets. In the ideal frictionless world, trade would smooth all shocks. With trade costs, though, trade cannot smooth all shocks; so storage also plays an important role in smoothing consumption.

Limited risk sharing, especially in the maize and rice markets, is cause for concern. An additional concern is that such risk-sharing is even lower for poorer countries. In rice, for example, low-income countries achieve only 38% of full insurance relative to almost complete insurance achieved by high-income countries. Similar results are seen in the wheat and maize markets. Improving risk sharing for poor countries can play a vital role in achieving food security. This chapter provides grounds for such a discussion.

2. BASIS RISK IN INDEX INSURANCE: LOWER TAIL DEPENDENCE AND THE DEMAND FOR WEATHER INSURANCE

Agriculture and agriculture-based livelihoods in developing countries are highly prone to weather shocks. Although there exist various informal mechanisms in rural communities that allow farmers to pool risks, such insurance is often partial and, moreover, provides limited insurance to individual households when shocks are widespread. Extreme climate events such as droughts, floods, and heat waves which affect farming communities in a region simultaneously are instances of correlated and widespread risks. There is substantial evidence that rural households in high-risk environments stick to low-return subsistence agriculture and cope with correlated shocks by liquidating productive assets to maintain consumption thus remaining trapped in poverty (Rosenzweig and Binswanger, 1993; Carter and Barrett, 2006; Dercon and Christiaensen, 2011).

Even though farmers in developing countries are typically poor and even though they bear the burden of volatile income streams, formal insurance products have had limited success (Mobarak and Rosenzweig, 2013). The difficulties of administering insurance programs tailored to the production histories of individual farmers have led to index insurance products where payouts are triggered by an index such as rainfall, temperature, or local average yields. Setting premiums is relatively easier because past data on indices of weather and average yield are more readily available than on individual production histories. As individual farmers have little or no influence on payouts, index-based insurance products are also less likely to fail due to asymmetry in information between the insurer and the insured. Despite the promise of index insurance, the record is mixed. In particular, the uptake of index insurance is poor, especially when it is not subsidized (Binswanger-Mkhize, 2012; Jensen and Barrett, 2017; Jensen, Barrett and Mude, 2016).

The literature has highlighted many reasons for the low uptake. These include the unfamiliarity among farmers of formal insurance, the lack of trust in the insurance provider, and the difficulties of communication resulting in poor understanding of the insurance product. Poor farmers also face liquidity constraints and insurance demand is highly sensitive to price (Cole et al., 2013; Cole, Stein and Tobacman, 2014; Gine, Townsend and Vickery, 2008).

However, even if the above factors were absent, research has highlighted the fundamental constraint of 'basis risk' which occurs because of an imperfect correlation between the index and farmer losses. If the association is weak, then index insurance might not be reliable (Moresink, Clarke, Mapfumo, 2016). Research has shown, both theoretically and empirically, that basis risk reduces the demand for insurance (Clarke, 2016; Elabed and Carter, 2015; Gine, Townsend and Vickery, 2008; Hill, Robles and Ceballos, 2016). The importance of acknowledging basis risk is stressed in a recent study that states "Discerning the magnitude and distribution of basis risk should be of utmost importance for organizations promoting index insurance products, lest they inadvertently peddle lottery tickets under an insurance label" (Jensen, Barrett and Mude, 2016).

Index insurance products are, at best, designed to offer protection against aggregate or covariate risks (Miranda, 1991; Ramaswami and Roe, 2004; Carter et al., 2014). The lack of a perfect association between the index and losses at the farmer level can, therefore, arise either because the index is not accurate or because losses are substantial. While previous work has established the sensitivity of insurance demand and farmer welfare to basis risk, there has not been much work on contract design that reduces basis risk. Chantarat et al. (2013) described index-based livestock insurance where the contract was based on a regression of historic mortality rates on an index of vegetative cover and therefore, was designed to minimize basis risk. In a similar vein, this chapter examines how rainfall insurance contracts in India can be designed to reduce basis risk. Our approach exploits the idea that the joint distribution of rainfall and output might be characterized by 'tail dependence'. This means that the associations between yield losses and index losses are stronger for large deviations than for small deviations. The major implication is that the value (to farmers) of index-based insurance relative to actuarial cost is highest for insurance against extreme or catastrophic losses (of the index) than for insurance against all losses. Or in simpler words, basis risk is the least for large deviations of the index. The goal of this chapter is to test this hypothesis.

The contribution of this chapter is two-fold. First, it adds to the slender work on how contracts can be designed to lower basis risk. Second, it uses general measures of association to characterize the dependence between the index and crop losses. Previous work has recognized that lower tail dependence characterizes the joint distribution of spatial yields (Du et al., 2018; Goodwin, 2014, Goodwin and Hungerford, 2016) and also the joint distribution of spatial rainfall (Aghakouchak, Ciach and Habib, 2010). The chapter argues that these two facts imply that the joint distribution of rainfall and yields will also exhibit lower tail dependence. Testing this hypothesis and examining its implications for the design of insurance is the contribution of this chapter.

The chapter estimates the tail dependence in the joint distribution of weather (i.e., rainfall) and yields using a district-level data set for India and for 9 major crops. Using maximum likelihood methods, the chapter estimates a number of copulas from the parametric families of elliptical copulas and the Archimedean copulas. The best-fit copulas are joined to a conceptual model of an insurance purchaser. The simulation of the copulas allows one to estimate the optimal insurance cover for a variety of insurance contracts that vary according to the index threshold value that triggers payouts. These results are compared to those obtained from a copula without tail dependence (the Gaussian copula).

A preview of the findings is as follows. We find that station-level rainfall in India does exhibit tail dependence and the joint distribution of district-level crop yields for nine major crops and rainfall index also exhibit tail dependence. This implies that the associations between yield losses and index losses are stronger for large deviations than for small deviations. Or that the basis risk is least for large deviations of the index. This is also confirmed by simulations that show that value to a risk-averse farmer of index-based insurance relative to actuarial cost is highest for insurance against extreme or catastrophic losses (of the index) than for insurance against all losses. Because of tail dependence, the demand for commercially priced rainfall insurance is more likely to be positive when coverage is restricted to extreme losses.

2.1 Background Evidence: Tail Dependence in Rainfall

As far as rainfall is the only component of aggregate shocks, a rainfall insurance contract would suffer from design basis risk. Ideally, this should be investigated by examining the association between area average yields and the rainfall index that is computed from a weather station within the region. Because of data considerations, the tail dependence and the copulas of joint distributions of area average yields and area average rainfall are estimated. However, this is not a major limitation because tail dependence in the joint distribution of these averages implies tail dependence in the joint distribution of area average yield and rainfall index.

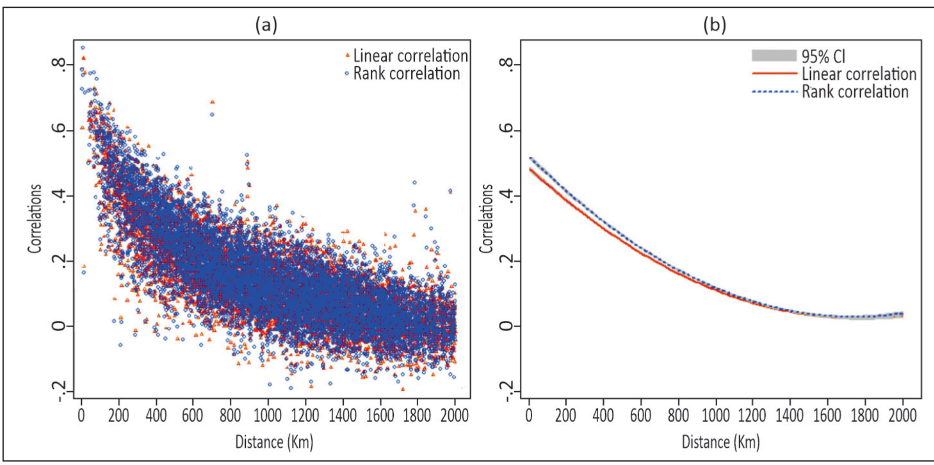
The reason is as follows. From other parts of the world, it has been found that rainfalls within a region are not only strongly correlated but, in fact, are characterized by tail dependence (e.g., Aghakouchak et al., 2015). Thus, an association of large deviations of area average yield with large deviations of area average rainfall automatically translates to an association of large deviations of area average yield with large deviations of a rainfall index derived from a location within that area.

To confirm the key fact of tail dependence in the distribution of rainfall in India, rainfall data from 137 weather stations of the Indian Meteorological Department is used. The complete data series is available from 1966 to 2007. Rainfall is highly seasonal, and the bulk of it is received from June to October. To make rainfall series comparable across stations and months, rainfall by months is standardized.

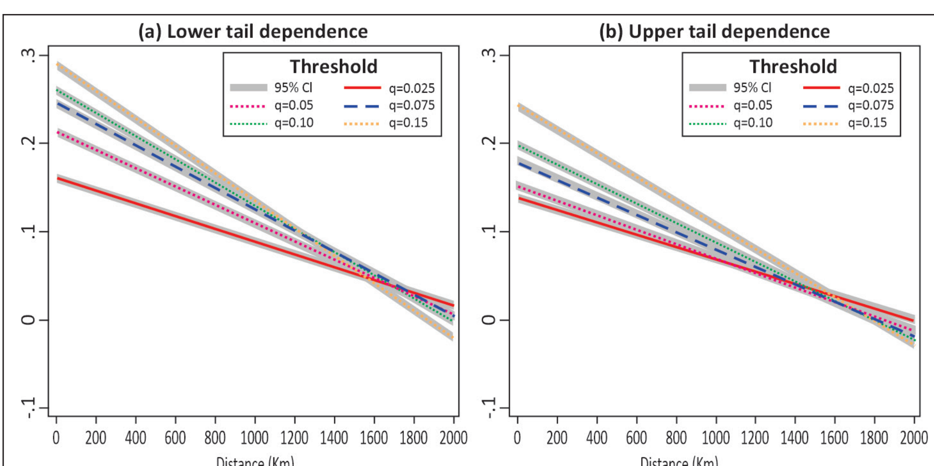
Figure 2.1(a) shows a scatter plot of pairwise linear and rank correlations between all the possible combinations of rainfall stations as a function of the distance between them. The right panel of the figure shows the best-fit curve to the rainfall station pair correlations. These clearly show that the joint association between rainfalls at two stations is inversely related to the distance between them. Interestingly the curve for rank correlation is above the curve for linear correlation when two stations are close to each other. But, the difference between the two narrows down as the distance between the stations increases. This is an indication of tail-dependence in rainfall as rank correlation is better suited at capturing nonlinear relationships between the variables.

Figure 2.1: Dependence in pairwise station rainfalls

(a) Correlation and distance



(b) Nonparametric tail-dependence and distance



Correlation is a global measure of association whereas we are interested in the association between random variables when they are at their extremes. To study the behavior of joint distribution of rainfalls at extremes we create a dataset of all possible combinations of rainfall station pairs. Using this, for each station pair, we generate a new dataset of lower and upper tail dependence coefficients.

We use a nonparametric estimator of tail dependence (Patton, 2013). The tail-dependence statistic looks at a specific portion of the tail in the joint distribution. Therefore, a threshold needs to be specified for estimation. This choice of threshold involves a trade-off in terms of bias in the estimate and its variance. For small (large) values of the threshold, the variance is large (small) and the bias is small (large). Note that the smaller the value of the threshold the more extreme deviations the tail dependence statistic will capture.

Figure 2.1(b) shows the best-fitted curves for the lower and upper tail dependence statistics for pair-wise rainfalls as a function of the distance between the stations. The tail dependence declines with distance, but the rate of decline is slower for lower values of the threshold.

2.2 The Joint Distribution of Average Area Yields and Average Area Rainfall

The association between average area yield and average area rainfall is studied. District yields are collected from the district database of the International Crops Research Institute for the Semi-Arid Tropics ICRISAT (http://vdsa.icrisat.ac.in/vdsa-database.htm) that is compiled from various official sources. To maintain consistency and comparability of time series across districts, data of the bifurcated districts is returned to the parent district based on the district boundaries in 1966.

The database covers 15 major crops across 311 districts in 19 states from the years 1966-67 to 2011-12. India receives 85% of its annual rainfall during the monsoon months of June to September. A rainfall insurance contract is meaningful therefore for crops grown during this period. These are called the *kharif* season crops (June to October). In the data set, these crops are Maize, Cotton, Sorghum, Finger millet, Pigeon pea, Soybean, Pearl millet, Groundnut and Rice. Crop yields typically exhibit significant upward trends over time due to technological changes. Yield deviations are estimated by fitting a linear trend to log yields of each crop of each district. The high-resolution gridded rainfall data from the Indian Meteorological Department is used to construct total *kharif* season rainfall as cumulative rainfall for the months from June to October. The cumulative seasonal rainfall is transformed into standardized deviations from their long-term normals.

Table 2.1 presents coefficients of linear and rank correlation between yield and rainfall deviations. As expected, both measures show a statistically significant positive association between yield and rainfall deviations, despite some difference in their magnitude.

Table 2.1: Linear and rank correlation between yield and rainfall deviations

Crops	(a)	(b)
	Pearson linear Correlation	**Spearman rank Correlation**
Maize	0.023	0.004
	(0.009)	(0.01)
Cotton	0.072	0.073
	(0.012)	(0.015)
Sorghum	0.104	0.109
	(0.01)	(0.01)
Finger millet	0.107	0.086
	(0.014)	(0.015)
Pigeon pea	0.145	0.131
	(0.009)	(0.009)
Soybean	0.169	0.122
	(0.018)	(0.017)
Pearl millet	0.183	0.183
	(0.011)	(0.011)
Groundnut	0.177	0.18
	(0.01)	(0.01)
Rice	0.277	0.267
	(0.008)	(0.009)

Note: Estimates based on district-level data from the VDSA-ICRISAT database. Bootstrapped (200 replications) standard errors in parenthesis.

Figure 2.2: Kernel density plots of ranks of yield and rainfall deviations

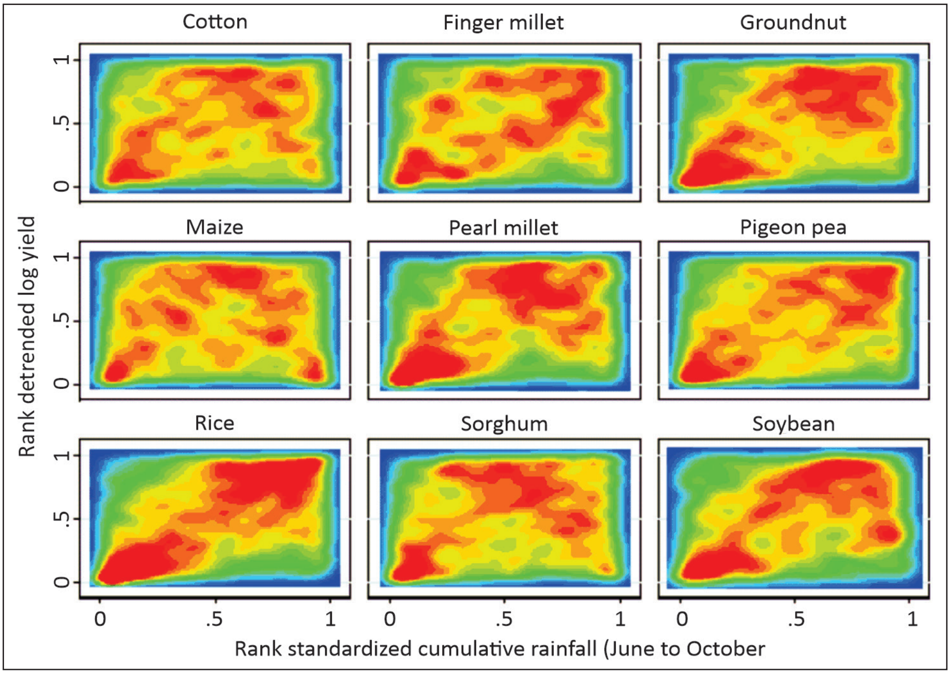
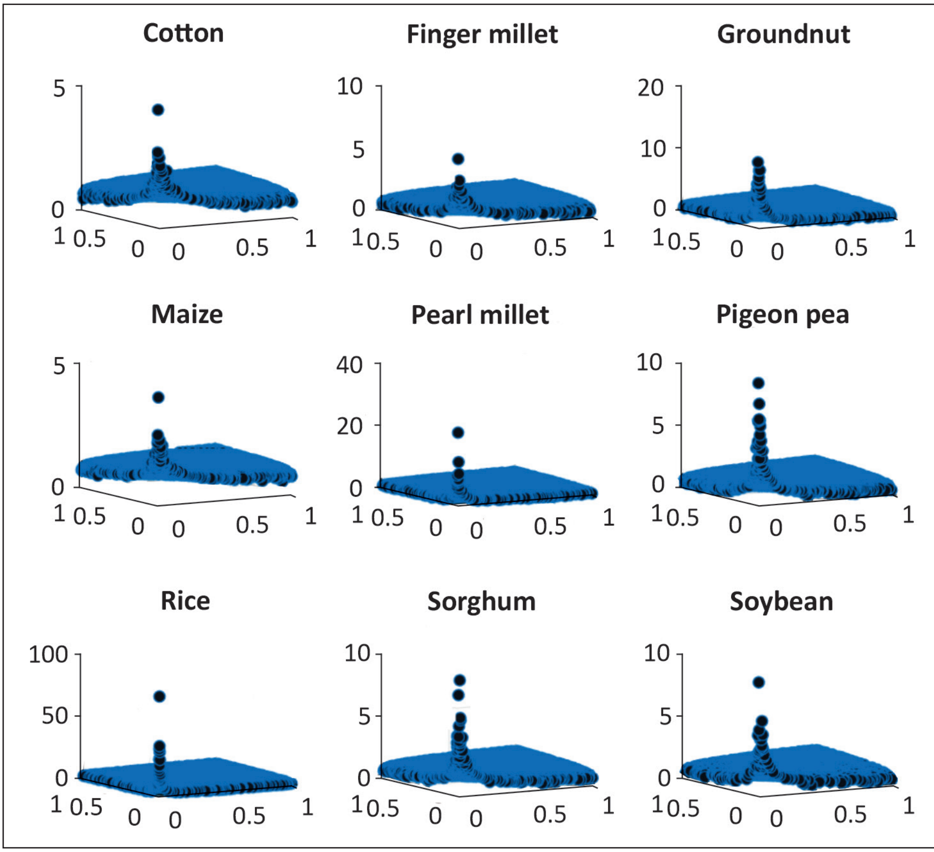


Figure 2.2 presents the bivariate kernel density plots of transformed yield and rainfall deviation. We observe clustering of yield and rainfall deviations in the lower-left corner of scatter plots for many of the crops. Such clustering corresponds to extreme shortfalls in yield and rainfall and implies a greater likelihood of simultaneous occurrence of these events.

Copula functions are used to capture the asymmetric dependence between yield and rainfall deviations by fitting copulas to rank-based empirical marginal distributions of yield and rainfall deviations. Based on the log-likelihood values, the Clayton copula is the best model to describe the dependence between yield and rainfall. This is not surprising as Clayton copula exhibits only lower tail dependence and no upper tail dependence. The estimated copula density for different crops is presented in Figure 2.3. As expected, all crops show significantly higher density at the lower tail. This further confirms that the association between yield and rainfall deviations is stronger at the lower tail. This means that when rainfall is abnormally low, yield losses are widespread. Therefore, the basis risk is low for an extreme shortfall in rainfall.

Figure 2.3: Estimated association between district-level crop yields and rainfalls



2.3 Implications for Rainfall Insurance

(i) Basis Risk

Our findings show that the joint density of yield and rainfall exhibits lower tail dependence, i.e., a stronger association between yield and rainfall when rainfall is abnormally low. This implies that the basis risk varies across the joint distribution of yield and index. This opens up the possibility of designing insurance such that it covers the losses with the least basis risk. Here, we analyze the implications of these findings for the demand and design of index insurance.

We use the Clarke (2016) catastrophe performance ratio to examine how tail dependence matters to basis risk. The ratio basically reflects the average amount a farmer gets back as claims per dollar paid as a commercial premium. A hypothetical rainfall insurance contract is considered. The payoffs are simulated using 10,000 draws of rainfall and yield from a Gaussian copula and from a copula exhibiting lower tail dependence. The correlation between the two variables is held constant across the two copulas. The comparison of the performance ratio across the two copulas is, then, revealing about the effect of tail dependence.

Figure 2.4: Expected claims to commercial premium ratio for All India

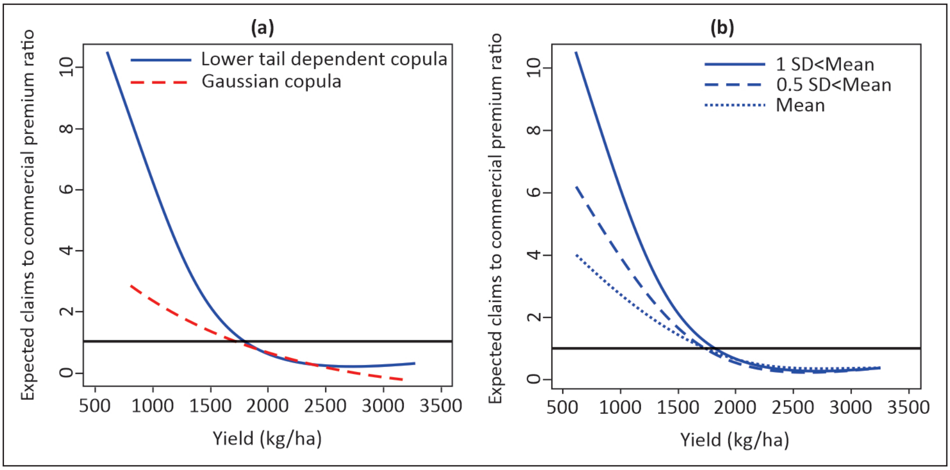


Figure 2.4 (a) plots the estimated relationship between claims to commercial premium ratio and yield from the simulated data, i.e.,

$$I(q) = E\left(\frac{\text{Max}\{\hat{R} - R, 0\}}{mP} | q\right) \qquad (2.1)$$

where R is cumulative kharif rainfall, $\hat{R}$ is the threshold that triggers payouts, q is crop yield, P is actuarially fair premium and m indicates the markup. The insurance contract parameter $\hat{R}$ is assumed to be one standard deviation below the mean rainfall and the markup (m) is assumed to be 1.56 times the actuarially fair premium. At this premium level, the catastrophic performance ratio is below 1 for the rainfall insurance contracts considered by Clarke et al. (2012). This is not true, however, for the payouts from rainfall contracts in Figure 2.5 The ratio from the normal distribution and from Clayton Copula are above 1 for low output levels. There is, however, a substantial divergence between the normal distribution and the Clayton copula at these low output levels. The catastrophic performance ratio is substantially higher for the Clayton copula. Thus, by the measures proposed by Moresink, Clarke and Mapfumo (2016), accounting for tail dependence markedly reduces basis risk.

Figure 2.4 (b) plots the Clayton copula-based catastrophic performance ratio for different levels of the deductible. $\hat{R}$ is chosen to be either the mean or 0.5 standard deviations below the mean or 1 standard deviation below the mean. It can be seen that as the deductible rises (i.e., $\hat{R}$ falls) so does the basis risk. Catastrophic insurance carries the least basis risk.

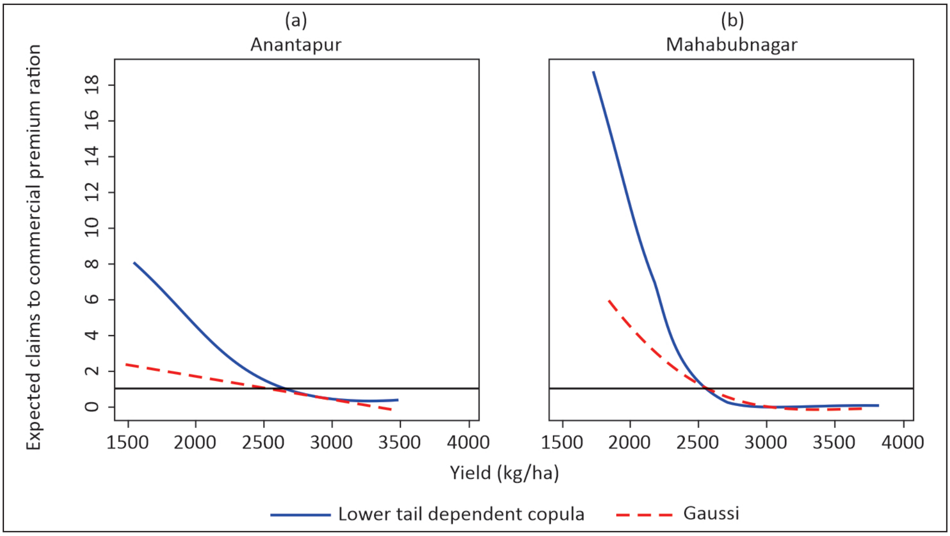
(ii) Optimal Insurance

To investigate further, two districts in India are analyzed, Mahabubnagar and Anantapur, that have been heavily researched for the extent of local risk sharing (e.g., Townsend, 1994). These districts are characterized by dependence on rainfed agriculture and vulnerability to droughts. Households in these districts have also been recently surveyed for their risk aversion using Binswanger-type lotteries (Binswanger, 1980; Cole et al., 2013) and we use those estimates.

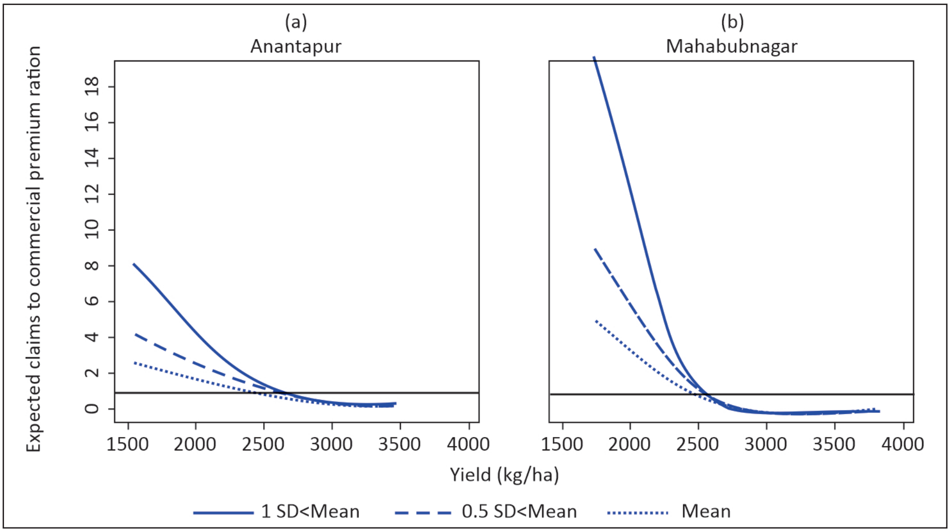
Figures 2.5 (a) and (b) show the catastrophe performance ratios for these districts. These pictures are very much like Figures 2.5 (a) and (b). Once again, basis risk is much lower relative to a Gaussian copula. Further, basis risk falls with a larger deductible.

Figure 2.5: Expected claims to commercial premium ratio for two districts of Andhra Pradesh

(a)

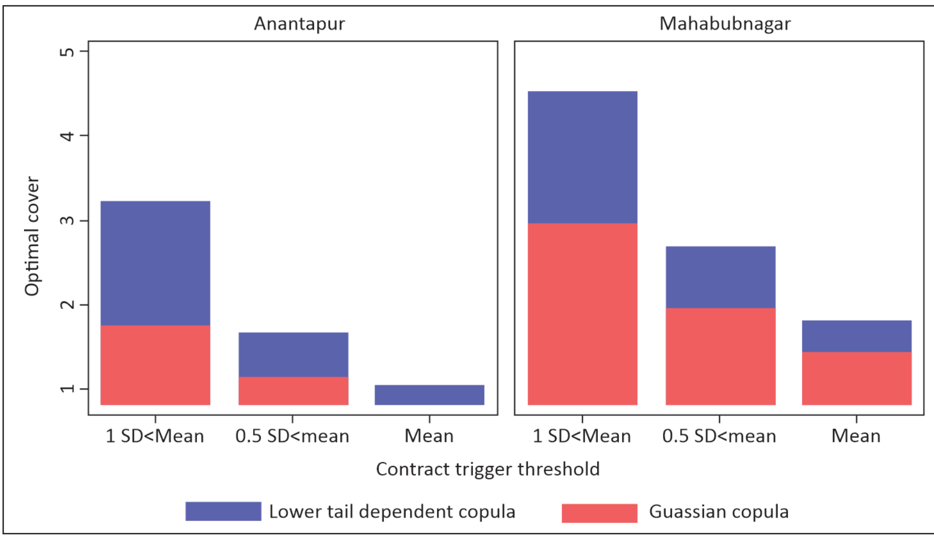


(b)



Finally, optimal insurance cover is computed with and without tail dependent yield and rainfall distribution and for insurance contracts that vary according to the index threshold value that triggers payouts. The results are displayed in Figure 2.6 where the computations assume markup to be zero. What is noteworthy about the results is that the optimal insurance cover is much larger with a tail dependent copula than with a Gaussian copula. This is consistent with the lower basis risk with a tail dependent copula.

Figure 2.6: Optimal cover for actuarially fair contract under different thresholds



The fact that contracts with the lowest threshold (highest deductible) have the lowest basis risk and the greatest demand for insurance, does not, however, mean that farmers necessarily prefer these contracts to all others.

2.4 Conclusion

Although cost-effective and free from moral hazard and adverse selection, index-based crop insurance products have seen poor uptake because of an imperfect association between index and crop loss that reduces the value of insurance and therefore its demand.

It is found that the association between crop yield and rainfall index characterized by the statistical property of 'tail dependence'. This implies that the associations between yield losses and index are stronger for large deviations than for small deviations. The most important implication of the findings is that, for farmers, the utility of index-based insurance relative to actuarial cost is more during extreme or catastrophic losses than for insurance against all losses. This opens up the issue of evaluating the cost-effectiveness of an insurance product that limits itself to compensation against extreme events. The findings also generate a need to systematically evaluate the basis risk and uptake for index insurance products that differ with respect to the contract threshold.

The idea behind heavily subsidizing insurance premiums is that subsidies are essential for the widespread uptake of insurance products. If so, the question is: What is the best way to provide a subsidy? The present analysis shows that crop losses are widespread during extreme climatic events such as droughts. This implies that a considerable proportion of farmers would benefit from a program that covers their risks during an extreme weather event. In other words, any form of insurance that protects from extreme losses is likely to be favored by a majority of the farmers. The actuarial cost of such an insurance scheme will be lower compared to normal insurance; hence less burden on the government exchequer. Indeed, a policy that completely subsidizes extreme loss insurance could possibly be revenue-neutral relative to an insurance program that covers crop losses based on rainfall deficit.

Extreme loss insurance programs are likely to be more useful to local aggregators of risk such as banks, producer companies, cooperatives, agri-business firms, and local governments. There is a very established protocol for drought relief expenditures by the government. However, its timeliness is often questioned because of the many layers of permissions required for such expenditures. On the other hand, an extreme loss insurance program offers the benefits of drought relief but in a timely manner.

It is noted that farmers may not purchase insurance for other reasons as well including poor understanding of the product, credit constraints, low trust in the insurance seller, and optimism about yields. If these are binding constraints, then again a reduction in basis risk may not impact the demand for insurance.

Finally, it is highlighted that tail dependence is unlikely to be India-specific since it flows from the nature of spatial associations of weather. Therefore, although our results are based on Indian data, the general lessons are available for other countries too.

3. GLOBAL FOOD PRICE SURGE, IN-KIND TRANSFERS, AND HOUSEHOLD WELFARE: EVIDENCE FROM INDIA

There is much debate on the impacts of high food prices on household welfare in developing countries (Swinnen, 2010). Since food is a necessity, the welfare effects of high food prices would be experienced universally. The major cause of concern is that as exposure to high food prices is proportional to its budget share in household expenditure, the worst affected population groups would be ones placed at the bottom of the income distribution (Easterly and Fischer, 2001). Therefore, rising food prices have become a matter of serious concern for developing countries, which are home to a majority of the world's poor (World Bank, 2008; IMF, 2008; Wodon et al., 2008).

In this chapter, the impact of high global food prices, primarily rice, and wheat, on the welfare of Indian households in studied. Much of the literature examining the welfare impacts of the 2007-08 surge in global food prices has concluded that high food prices are bad for the poor (Headey and Fan, 2008; Ivanic and Martin, 2008; Wodon and Zaman, 2010; De Hoyos and Medvedev, 2011; Ivanic and Martin, 2014). In general, an increase in food prices will affect the welfare of both consumers and producers, but in different directions (Budd, 1993; Swinnen, 2010). Consumers may lose as higher food prices will make food less affordable and reduce the real value of income. Producers may gain as higher food prices will increase the returns from food cultivation. Since farm households in developing countries also produce food, the total effect will depend upon a household's net consumer or net producer status (Deaton, 1989). In addition, higher food prices may also lead to higher wages and a greater derived demand for labor, inputs, and other commodities locally (Ravallion, 1990; Gulati and Narayanan, 2003; Aksoy and Hoekman, 2010; Jacoby, 2016; Headey, 2018; Van Campenhout et al., 2018). Therefore, the net welfare effects of high food prices are ambiguous and open to rigorous empirical explorations.

Governments in developing countries often intervene heavily in the food sector and generally provide safety nets to ensure the food and nutrition security of the most vulnerable populations. Safety nets in the form of food vouchers, in-kind food transfers, or employment schemes directly influence the relationship between food prices and household welfare (Aksoy and Hoekman, 2010; Narayanan and Gerber, 2017; Narayanan et al., 2019; Gadenne et al., 2021). While concerns about high prices are legitimate, one often ignored aspect is the mediating role of safety net programs operational in the country. The ways in which, for example, in-kind food transfers interact with the welfare effects of high food prices are not obvious and are a function of a variety of factors, including how well these policies are targeted to the poor and the vulnerable. In this chapter, the role of one such safety net operational in India is studied, the availability of highly subsidized food via the Public Distribution System (PDS) of India. Since the PDS provides highly subsidized rice and wheat to the poor, the welfare impacts of high food prices on Indian households are not entirely obvious. Moreover, the PDS itself can turn out to be a coping strategy for households. This is something that is explored in this chapter.

This chapter uses the Indian Human Development Survey (IHDS) data for empirical analysis. The IHDS offers nationally represented household-level panel data covering more than 30,000 households tracked over two survey rounds conducted in 2004-05 and 2011-12. It provides data on various household characteristics, including income and consumption patterns and individual-level data on workdays, hours, and participation in different work activities. There are multiple advantages of using the IHDS data. First, the timing of the IHDS surveys is appropriate to study the 2007-08 surge in global price of rice and wheat which are a staple of Indian households. Second, the IHDS is the only large-scale household-level panel data for India and allows me to use a household fixed effects strategy that rules out the influence of all time-invariant variables. Third, the baseline IHDS survey has information on cropping patterns and crop production enabling identification of rice and wheat cultivating and net producer and consumer households. Fourth, IHDS has rich information on households' access to different government sponsored safety nets, like in-kind food subsidies and large-scale workfare programs. Finally, it also enables study of shifts in food consumption behavior and indirect effects in the form of higher agricultural expenditures, wages, and farm and nonfarm labor usage of net rice and wheat producing and consuming households.

It is found that high global rice and wheat prices led to an increase in household consumption expenditure and the share of non-food component for rice and wheat cultivating households. These welfare gains mainly accrued to net producers. It is observed that net producer households were able to resist a rise in their per capita spending and consumption of rice and wheat by decreasing consumption of market purchased rice and wheat and increasing consumption of government-subsidized PDS rice and wheat. On the other hand, net consumer households experienced a decline in the total per capita consumption of rice and wheat even though they substituted their market purchases with homegrown produce. Although a decline is observed in the consumption of rice and wheat for net consumer households, it is found that they increased their consumption of coarse cereals and were able to maintain their total calorie intakes. These coping strategies were enough to ensure non-rising total food expenditures for the households. Finally, some evidence is found that high rice and wheat prices induced working-age adult males in net producer households to increase total workdays and workdays on their own farm.

This chapter contributes to the literature studying the welfare impacts of high food prices. Early studies have used simulations based on Deaton's (1989) net benefit approach to analyze the welfare consequences of the 2007-08 surge in food prices (Ivanic and Martin, 2008; De Hoyos and Medvedev, 2011; Ivanic et al., 2012). Basic insights from Deaton (1989) are followed but a reduced form approach to directly estimate the welfare impacts are used. The reduced form household fixed effects regressions allow for uncovering a more nuanced consumption and labor reallocation response than what has been captured in previous studies. In particular, the insurance role of in-kind food transfers which invariably influences the net welfare gains and losses are captured.

This chapter also relates to reduced form studies on the impacts of commodity price shocks on household welfare. There is evidence that cycles in prices of cash crops like cocoa and coffee have a strong passthrough to consumption, nutrition, and child health and schooling of grower households (Kruger, 2007; Miller and Urdinola, 2010; Cogneau and Jedwab, 2012; Bladimir, 2020; Kebede, 2021). Moreover, commodity price shocks have also been linked to social unrest and civil conflicts (Kamola, 2007; Brückner and Ciccone, 2010; Dube and Vargas, 2013; Bellemare, 2015). A few studies have also looked at the impact of food prices on household welfare (Edmonds and Pavnik, 2005; Tandon, 2015; Bellemare et al., 2018; Yamauchi and Larson, 2019). In comparison to cash crops and other non-food commodity prices, the channels through which food prices interact with household welfare are much more complex. In particular, a rise in the price of cash crops may not lead to a decline in the real value of consumption for grower households. However, it is found in this analysis that the labor reallocation effects of high food prices are consistent with what Kebede (2021) reports in the case of coffee prices for Ethiopia.

Finally, this chapter also connects with the literature debating the welfare impacts of in-kind food transfers. The insurance role of in-kind food transfers has been written about in the policy community (Kotwal et al., 2011; Dreze, 2011) and has recently been theoretically and empirically demonstrated in Gadenne (2020) and Gadenne et al. (2021). Consistent with Gadenne et al. (2021), the present study also finds evidence that in-kind food subsidies provided by India’s Public Distribution System insulated households from loss in per capita food consumption due to high food prices.

3.1 Data and Summary Statistics

(i) Household and individual data

Data from the Indian Human Development Surveys (IHDS) (Desai and Vanneman, 2010; 2018) is used. The IHDS project is jointly managed by the

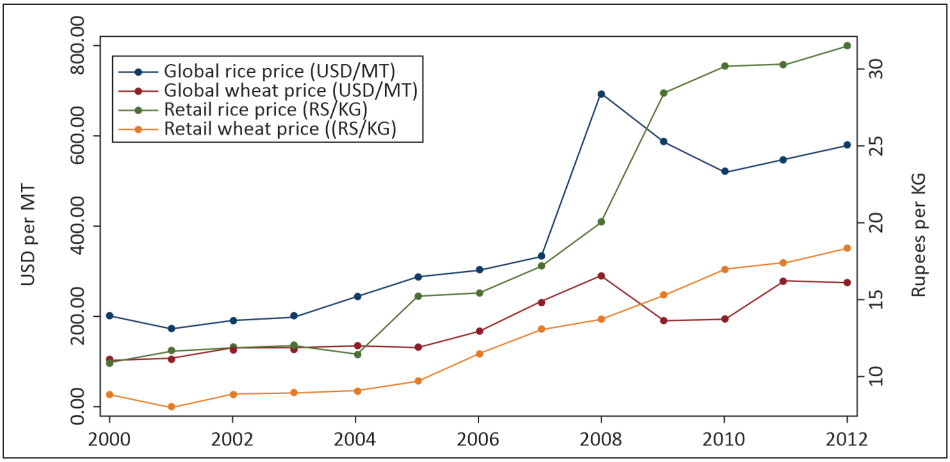
National Council of Applied Economic Research (NCAER) India, the University of Maryland, Indiana University, and the University of Michigan. The IHDS surveys are designed to collect household and individual-level data on a wide variety of indicators ranging from household income, expenditure, assets, and employment to different human development indicators, including education, caste, gender relations, local infrastructure, and availability of facilities, fertility and health.

Two rounds of the IHDS are publicly available. The first round of the survey was conducted in 2004-05 on more than 40,000 households and covered both urban and rural regions in all states of India. The second round was conducted in 2011-12. I treat the first IHDS survey as the baseline and the second survey as the endline. The most important aspect of these surveys is that 85% of the same households could be reinterviewed in 2011-12 making it the only large-scale and pan-India household-level panel data. The panel aspect of the IHDS data is critical for this study as the empirical strategy relies on household fixed effects for netting out household-specific time-invariant observed and unobserved variables. Another important feature of these surveys is that data on agricultural activities of rural households was also collected. This included data on the cropping patterns and the production quantities of different crops. However, data on cropping patterns and crop production is only available for the baseline period. This data is used to identify the rice and wheat growing and net producer and net consumer households in the baseline period.

(ii) Food prices

Rice and wheat price data is collected at three levels; global, domestic retail, and farmgate prices. The international price of rice and wheat comes from the International Monetary Fund's commodity prices dataset. The price of Thai 5% broken rice and US hard red wheat in USD per metric ton are considered as global prices of the two commodities. State-level retail prices prevailing in the retail shops and government administered Minimum Support Prices (MSP) of rice and wheat are also used.

Figure 3.1. Rice and wheat prices in global and domestic markets



Notes: I use the price of Thai rice and US wheat in USD per metric ton as the global price of the two commodities. The retail prices are prices of rice and wheat prevailing in the retail shops. The retail price data comes from the price monitoring bureau of the Department of Consumer Affairs, Ministry of Agriculture, Government of India. These are nominal prices.

Figure 3.1 plots the global and domestic food prices in nominal terms for the period of analysis. Between 2004-05 and 2011-12, the global price of rice increased from 282 to 576 USD per metric ton. Likewise, the global price of wheat increased from 130 to 277 USD per metric ton. Both commodities show more than double the increase in global prices. A similar increase is also visible for domestic prices. With international prices increasing dramatically around 2007, the Indian government was unable to maintain stable price levels with the result that the price of rice and wheat shot upward in the domestic market as well (Mishra and Roy, 2012).

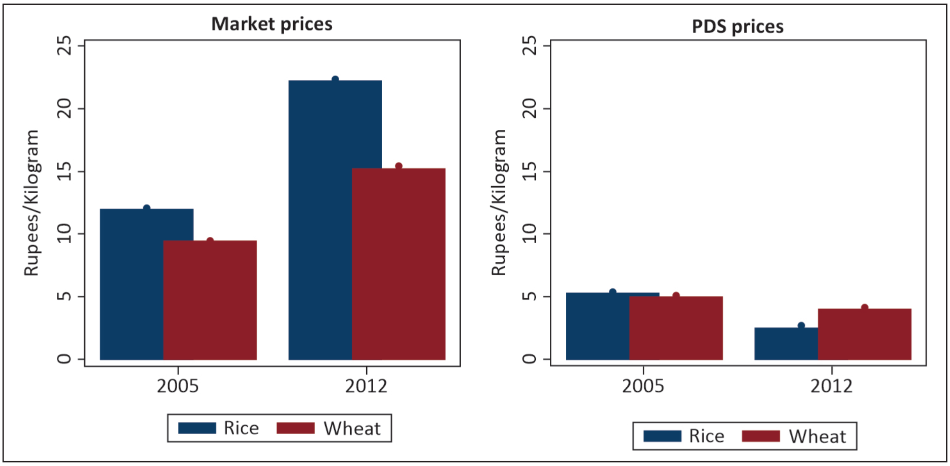
Empirical framework in the study, would partially rest on the assumption that rice and wheat cultivating households cannot influence global rice and wheat prices. To argue that this assumption is reasonable in this context, the events which led to the unprecedented surge in global food prices during 2007-08 are briefly documented. In the case of rice, global markets are thin meaning that only a small proportion of global production is traded and most of the production and trade is concentrated in Asia. Although Thailand has been the major exporter of rice in global food markets, India has also emerged as a major exporter in recent years. On average, Thailand, India, and

Vietnam account for around 60% of the total world exports. So India does not satisfy the assumption of a price taker in the global rice markets. It has been documented that export bans by Vietnam and India as a response to rising rice prices were the main reason for panic among major rice importers which further led to a surge in rice prices (Headey and Fan, 2008).

Global wheat markets are less thin than rice as major producers and exporters are rich temperate countries. The rise in global wheat prices in 2007-08 was triggered by poor harvests experienced by many of the major exporters of wheat. Australia, The United States, Russia, and Ukraine all witnessed a decline in production during the period. Export bans by major wheat exporters triggered by low stocks and poor harvests created panic in global food markets (Headey and Fan, 2008; Abbott, 2011).

In general, the global food crises may have been triggered by the actions of a few countries but the unprecedented and sustained increase is mainly attributed to the contagion effect and ensuing countercyclical trade policies (Timmer, 2008; Mitra and Josling, 2009; Abbott 2011; Giordani et al., 2016).

Figure 3.2. Market purchased and PDS price of rice and wheat



Notes: Market and PDS price of rice and wheat reported in the IHDS surveys with 95% confidence intervals. These are nominal prices.

Another set of prices important in this context is the highly subsidized price of rice and wheat distributed via the Public Distribution System (PDS) of India. Figure 3.2 shows that market purchased and PDS purchased price of rice and wheat. The PDS price of rice and wheat is much lower than the market price in both surveys. Moreover, the price of market purchased rice and wheat shows an increase but the PDS price shows a decline during the two time periods. This is because many states either reduced PDS prices or expanded the coverage, making the PDS subsidies more generous (Gadenne, 2021).

3.2 Methodology

To estimate the passthrough of global rice and wheat price surge on Indian households' consumption expenditure and other outcomes, I estimate the following equation is esimated:

$$\begin{aligned} Y_{ist} = \alpha_i + \tau_t + \mu_{st} + \delta^{RICE} \ln (\text{WPRICE})_t \times \text{SARICE}_i \\ + \delta^{\text{WHEAT}} \ln (\text{WPWHEAT})_t \times \text{SAWHEAT}_i + \varepsilon_{ist} \end{aligned} \quad (3.1)$$

where Y_{ist} is the outcome variable of interest for household *i* in state *s* for year *t*. The first interaction is of global rice prices (WPRICE) with households' proportion of area under rice (SARICE) and the second interaction is of global wheat prices (WPWHEAT) with households' proportion of area under wheat (SAWHEAT). An increase in prices may itself lead to increased acreage under rice and wheat. By using households' rice and wheat acreage at the baseline, the influence of endogenous acreage changes from the estimates is ruled out. Household fixed-effects α_i are included in equation (3.1) to control for all observed and unobserved time-invariant factors influencing household outcomes. The equation also includes time fixed effects τ_t and state-specific time fixed effects μ_{st}. These control for overall macroeconomic shocks and state-level policy changes correlated with global food prices. State time fixed effects also control for state-level changes in prices hence their inclusion also takes care of an increase in consumption expenditures due to a general rise in prices.

The impact of rice and wheat prices is captured by coefficients δ^{RICE} and δ^{WHEAT} which reflect the net effect of prices on households based on their area under rice and wheat cultivation. What should be the expected direction of these impacts? Since rice and wheat are a necessity, an increase in their prices should lead to reduced real income or real consumption expenditure. For rice and wheat producer households specifically, there will be an additional positive income effect due to higher prices. The coefficient on the interaction terms, therefore, captures the net effect for rice and wheat producing households. One could expect them to have a positive sign indicating that higher prices have a net positive effect on the welfare of producer households.

The sensitivity of estimates in equation (3.1) is also tested to addition of some key household level covariates. Operated area, cultivated area, and irrigated area are considered to control for any expansion as a supply response to high prices. The household's ownership of a BPL ration card, which would enable them to access subsidized rice and wheat, as controls is also added. These income gains may also come about because of participation in wage work under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA). MGNREGA is India's large-scale anti-poverty rural workfare program. It was introduced in 2005 and provides 100 days per year of voluntary employment at minimum wages to individuals in the working age group. The MGNREGA is mostly operational in rural areas and provides unskilled labor employment on local public work projects. The introduction of MGNREGA coincides with the baseline period; therefore, the estimated coefficients may just be capturing higher rural incomes due to households participating in MGNREGA. To control for this, a dummy variable is included for any member of the household participating in MGNREGA. Finally, monetary benefits received from other government programs are also considered.

A dimension of heterogeneity worth highlighting is based on the net consumer or producer status of households. Although equation (3.1) captures the average effect of high prices for food cultivating households, it will vary based on whether the household is a net producer or a net consumer. The net food producer or consumer status is not captured by the proportion of area under rice and wheat cultivation. A household may have all cultivable area under food cultivation but may still be a net food consumer. To capture such heterogeneity, equation (3.1) is estimated on subsamples of net rice and wheat producing and consuming households.

Finally, an attempt is made to capture some of the indirect effects of high rice and wheat prices. A rise in prices may induce a supply response in the sense that farmers may increase the production of rice and wheat. This, in turn, may lead to higher demand for agricultural inputs. If the supply of inputs doesn't rise concurrently, input prices and farmers' cost of cultivation may go up. The study tests whether agricultural expenditures, agricultural labor use, and intensity increased due to a rise in rice and wheat prices.

3.3 Results

(i) Effect of high food prices on rice and wheat cultivating households

Table 3.1 presents the estimates from equation (3.1) for three outcome variables - log of monthly per capita consumption expenditure, a dummy for whether the household is below the poverty line, and share of non-food in total consumption expenditure. In specification 1, where the dependent variable is the log of monthly per capita consumption expenditure, the estimated coefficients on the interaction terms for both rice and wheat are positive and statistically significant. This implies that a rise in rice and wheat prices led to an increase in the cultivating households' consumption expenditure. In terms of magnitude, a doubling of global rice price between 2004-05 and 2011-12 led to a 4.5 percent or a 64 rupee increase in monthly per capita consumption expenditure for rice cultivating households. Likewise, a doubling of global wheat prices led to a 6.5 percent or a 93 rupee increase in monthly per capita consumption expenditure for wheat cultivating households.

A rise in rice price also seems to translate into an increase in the share of non-food in total expenditure. In terms of magnitude, the doubling of rice prices led to a 3 percentage point increase in the share of expenditure on non-food items for rice cultivating households. These estimates are based on 50 percent area under rice or wheat and the mean per capita consumption expenditure of rupees 1430 estimated for the baseline period. Note that the marginal effect of global prices is a function of the cultivated area under rice and wheat; hence will vary with their acreage. To see whether the estimates for rice price and wheat price are statistically different from each other, a t-test of differences in coefficients is conducted. Based on the results, one is unable to reject the null hypothesis that these estimates are different for all three welfare measures. Table 3.1 also presents estimates from specifications where household level additional controls variables are added in the regressions. The inclusion of covariates only has a minor effect on the original estimates.

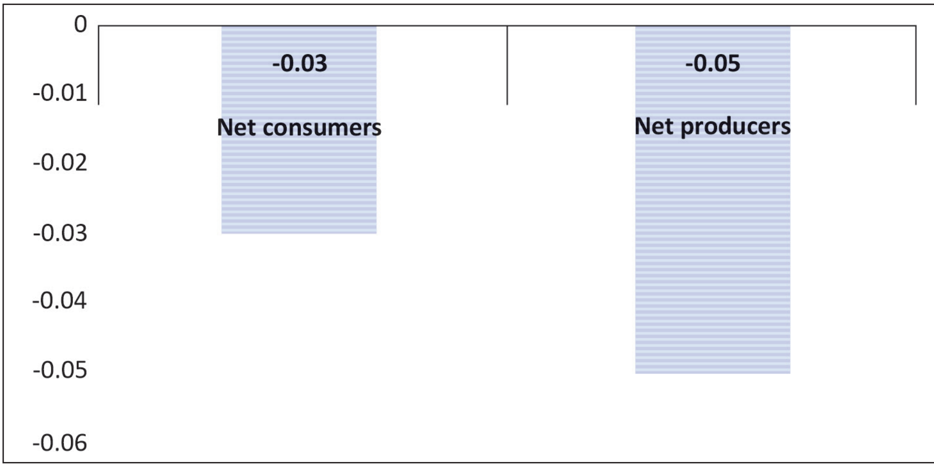
On average, India has exported only 4% and 2% of its total rice and wheat production between 2000 and 2010. This is a very small proportion and would mainly be driven by surplus food production from states like Punjab and Haryana. In that sense, if Indian rice and wheat farmers can influence global prices, then such farmers should most certainly be surplus producing farmers of these two states. To test whether surplus rice and wheat producing farmers from Punjab and Haryana are driving these estimates, the last specification for each dependent variable presents the estimates after removing the states of Punjab and Haryana from the sample (columns 3, 6, and 9). These remain comparable to the earlier estimates.

Table 3.1. Measures of welfare and global rice and wheat prices

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Ln(Monthly per capita consumption expenditure)			Headcount poverty			Share of non-food expenditure		
	All states	All states	Without Punjab and Haryana	All states	All states	Without Punjab and Haryana	All states	All states	Without Punjab and Haryana
Ln (WPRICE)×SARICE	0.090**	0.100**	0.093**	-0.042	-0.045	-0.043	0.060***	0.058***	0.057***
	(0.046)	(0.045)	(0.047)	(0.032)	(0.032)	(0.033)	(0.012)	(0.012)	(0.012)
Ln (WPWHEAT)×SAWHEAT	0.129**	0.158***	0.106*	-0.063	-0.074*	-0.059	0.004	0.006	-0.010
	(0.061)	(0.060)	(0.063)	(0.044)	(0.044)	(0.046)	(0.019)	(0.019)	(0.019)
Observations	33,132	33,132	31,142	33,168	33,168	31,174	33,132	33,132	31,142
R-squared	0.756	0.758	0.751	0.639	0.640	0.637	0.628	0.630	0.631
F stat	3.747	13.87	2.965	1.837	4.076	1.571	11.96	10.08	10.78

*Notes: The dependent variables are the monthly per capita consumption expenditure in logs, a dummy variable for whether the household is below the official poverty line, and the proportion of non-food expenditure in total consumption expenditure. WPRICE and WPWHEAT are the global rice and wheat prices respectively. SARICE and SAWHEAT are the proportions of cropped area under rice and wheat by the household. The regressions include household fixed effects, time fixed effects, state-time fixed effects, and dummies for the month of the survey. BPL stands for below poverty line and PDS stands for the Public Distribution System of India. Standard errors are reported in parentheses and are clustered at the PSU/village level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.*

Figure 3.3. Changes in poverty rates of net consumers and producers of food between 2005 and 2012



Notes. Figure shows the reduction in the proportion of poor between 2005 and 2012 for the net rice and wheat producing and consuming households. Estimates based on the Indian Human Development Surveys.

It is found that all welfare gains of high rice and wheat prices accrued to net producer households. Figure 3.3 shows that during the period of rising global and domestic rice and wheat prices, poverty among net rice and wheat producers declined faster than net consumers. These effects seem to be driven by welfare gains of high rice prices for rice cultivating households. In terms of magnitude, a doubling of rice prices during the period led to an 8.5 percent or 122 rupees increase in consumption expenditure, a 4 percentage point decline in headcount poverty, and a 5.4 percentage point increase in non-food share for net rice producer households.

(ii) In-kind food subsidies as insurance

A priori, one would expect net consumers to experience a welfare loss due to expensive food, but evidence of this is not found in this analysis. One reason for this may be the possibility that households replaced expensive market-purchased rice and wheat with cheaper PDS grains or other cereals. To explore this, per capita consumption of market purchased, PDS purchased, homegrown, and other cereals are regressed on the interaction terms with household, time, and state-time fixed effects. These estimates are presented in Table 3.2.

Table 3.2. Monthly per capita rice-wheat and other cereals consumption of net consumers and producers and rice and wheat prices

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Rice and wheat total	Rice and wheat homegrown	Rice and wheat PDS	Rice and wheat market	Other cereals	Total cereals	Calories consumed
	(kg/person)						(person/day)
	Net consumers						
Ln(WPRICE)×SARICE	-1.905***	0.108*	0.367	-2.379***	1.034***	-0.870	-12.20
	(0.498)	(0.057)	(0.393)	(0.569)	(0.222)	(0.534)	(108.47)
Ln(WPWHEAT)×SAWHEAT	-1.338*	0.164***	1.464**	-2.966***	1.146***	-0.192	186.59
	(0.685)	(0.060)	(0.584)	(0.801)	(0.330)	(0.699)	(128.27)
	Net producers						
Ln(WPRICE)×SARICE	-0.513	0.055	1.137***	-1.704***	0.736***	0.224	-30.16
	(0.530)	(0.052)	(0.303)	(0.557)	(0.239)	(0.590)	(113.40)
Ln(WPWHEAT)×SAWHEAT	-0.063	-0.123	0.902**	-0.836	0.443	0.381	142.69
	(0.792)	(0.075)	(0.446)	(0.808)	(0.405)	(0.813)	(191.13)

*Notes: WPRICE and WPWHEAT are the global rice and wheat prices respectively. SARICE and SAWHEAT are the proportions of cropped area under rice and wheat by the household. The regressions include household fixed effects, time fixed effects, state-time fixed effects. State fixed effects are absorbed by household fixed effects. Rice and wheat total include market purchased, homegrown and PDS rice and wheat. Other cereals include cereals other than rice and wheat. Total cereals include all cereals including rice and wheat. Total calories consumed are estimates using food items data reported in the IHDS survey. The food conversion factors used are extracted from the ones reported in the National Sample Survey's, Nutritional Intakes in India Reports for 2004-05 and 2010-2011. Net producers are defined as households whose total consumption of rice and wheat is less than their total production of rice and wheat in the baseline year. All others are defined as net consumer households. Standard errors are reported in parentheses and are clustered at the PSU/village level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.*

A decline in total per capita consumption of rice and wheat in net consumer households is observed. This decline for net consumer households was driven by their reduced consumption of expensive market-purchased rice and wheat. This is the consumption effect of high food prices. The net consumer households substituted expensive market rice and wheat with homegrown and subsidized PDS rice and wheat but this was not enough to offset the decline in their total consumption of the two cereals. These households maintained their total cereal consumption by increasing the consumption of coarse cereals. In fact, in terms of magnitude, shifting to coarse cereals was the dominant strategy to offset the reduced consumption of market purchased rice and wheat for net consumer households.

A decline in market purchased rice and wheat is also observed for net producer households, but the decline is mainly driven by high rice prices and is lesser in magnitude. Moreover, net producer households were almost completely able to offset their decline in consumption of market purchased rice and wheat by increasing consumption of PDS rice and wheat. The PDS consumption shows a greater response to rice prices than wheat. The insurance effect of PDS subsidy seems to be dominant for the net producer households as they were able to recover almost all the decline in their total cereal consumption from higher consumption of PDS grains. Another interesting observation is that net producer households did not increase the consumption of homegrown rice and wheat to substitute for expensive market rice and wheat probably because of a higher opportunity cost of consuming home-produced grains and the availability of a cheaper substitute in the form of PDS grains. An increase in the coarse cereal consumption is observed for the net producers also but the magnitude is much less than that of the net consumers.

The total calorie intakes for households using the item-wise food consumption available in the two rounds of the IHDS survey is also calculated. The conversion tables in the National Sample Survey's Nutritional Intake in India reports for 2004-05 and 2010-11 are used to calculate the total calorie intakes. The last column of Table 3.2 reports the estimates with per capita per day calorie intakes as the dependent variable. It is found that both net consumer and producer households were able to maintain their total calorie intakes during the period. Although both net consumer and producer households relied on PDS to maintain their consumption of rice and wheat, net producer households were more successful in using PDS as a coping strategy. There is evidence that PDS became more generous during the period both in terms of expansion and efficiency in operations (Bhattacharya et al., 2017; Krishnamurthy et al., 2017; Gadenne, 2021). Desai (2015) reports that more people were using the PDS during 2004-05 and 2011-12.

(iii) Some indirect effects

Table 3.3. Cultivable area, irrigation and agricultural expenditures of net consumers and producers and global rice and wheat prices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Operated area (hectare)	Cultivated area (hectare)	Irrigated area (hectare)	Hired labor exp. (rupees)	Wage (rupees/day)	Agri. exp. (rupees)	Tractor (Dummy)	New machine exp. (rupees)	Agri. loan repaid (rupees)	Loan repaid (dummy)
	Net consumers									
Ln(WPRICE)×SARICE	-0.023	0.436***	-0.178*	-1,290.9**	54.1	-1,789.3	0.001	-954.7	815.6	0.039
	(0.424)	(0.137)	(0.105)	(611.8)	(76.3)	(1,645.9)	(0.008)	(724.9)	(612.3)	(0.042)
Ln(WPWHEAT)×SAWHEAT	0.412	0.256	-0.631***	-286.4	19.3	-5,984.6	-0.014	1,537.3	-448.7	-0.061
	(0.373)	(0.215)	(0.179)	(867.1)	(97.2)	(4,407.4)	(0.019)	(2,577.6)	(748.2)	(0.064)
	Net producers									
Ln(WPRICE)×SARICE	1.531***	1.263***	0.277	-5,951.8***	-50.2	-15,901.3*	-0.038	-1,000.5	6,111.8**	0.123***
	(0.253)	(0.257)	(0.200)	(2,252.5)	(53.8)	(8,871.6)	(0.027)	(4,328.3)	(3,108.9)	(0.043)
Ln(WPWHEAT)×SAWHEAT	1.297***	1.294***	0.154	-2,597.0	-170.2	8,187.9	-0.001	7,655.1	4,088.6	0.143**
	(0.388)	(0.375)	(0.322)	(2,137.2)	(135.3)	(12,826.6)	(0.049)	(7,362.4)	(3,978.6)	(0.068)

*Notes: WPRICE and WPWHEAT are the global rice and wheat prices respectively. SARICE and SAWHEAT are the proportions of cropped area under rice and wheat by the household. The regressions include household fixed effects, time fixed effects, state-time fixed effects, and dummies for the month of the survey. State fixed effects are absorbed by household fixed effects. Hired labor and total agricultural expenditures are for the whole year. Net producers are defined as households whose total consumption of rice and wheat is less than their total production of rice and wheat in the baseline year. All others are defined as net consumer households. Standard errors are reported in parentheses and are clustered at the PSU/village level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.*

Table 3.3, explores whether higher rice and wheat prices had a supply response in the form of an increase in area under cultivation and irrigation. It is seen whether the indirect effects of higher prices resulted in higher agricultural expenditures and wages paid to hired labor. It is found that higher rice and wheat prices did lead to greater operated and cultivated area in net producer households. For net consumer households, high rice prices did lead to an increase in the cultivated area but the magnitude of increase was much less than net producer households. Moreover, net consumer households registered a decline in the irrigated area whereas there was no change in irrigated area for net producer households.

A supply response can also lead to a higher wage bill. On the contrary, it is found that the total wages paid to hired labor declined in both sets of households. The major decline, however, both in terms of magnitude and statistical significance is seen for rice cultivating net producer households. There is also no statistically significant change in the wage rate for hired labor paid by the households. The decline in hired labor expenditure among net producers may be due to greater use of machinery in farm operations. No such evidence is found as rice and wheat prices are uncorrelated with tractor ownership or greater expenditure on farms machinery and equipment (Table 3.3, columns 7 and 8). Overall, no evidence of an increase in the total agricultural expenditures and wages paid by the households is found. Interestingly, it is observed that the likelihood of loan repayment and the amount of payment made as agricultural loans increased for net producer households.

3.4 Conclusion

This chapter studies the welfare impacts of high rice and wheat prices on households in India. The analysis also demonstrates the significant heterogeneity that may exist in such impacts. It is observed that, overall, high rice and wheat prices were beneficial for cultivating households. It is also found that this overall effect was driven by the strong and dominant positive income effect for net producer households. Both net producers and consumers were able to resist a rise in their total expenditure on cereals and food budget but through different means. Net consumers substituted market purchased rice and wheat mainly with home produced rice and wheat and other cereals but net producers substituted market purchased rice and wheat with PDS rice and wheat and other cereals. The role of subsidized PDS rice and wheat in stabilizing total food consumption was evident in both net consumer and producer households but it was dominant for net producer households.

These results can be seen from two dimensions. The first is that higher food prices can generally be beneficial for food producers at the expense of net consumers. Moreover, if safety nets in the form of in-kind food transfers are in place; concerns about the food security of the poor and the vulnerable are misplaced. As this study shows, in-kind food transfers insulate households from high food prices. What is important, however, is the right targeting of these subsidies. In this case, evidence shows that access to government-subsidized grains improved disproportionately for net producers who seem better off in terms of their asset holdings, incomes, and consumption expenditures and were not the worst affected by high food prices. A second point worth noting is that net consumers, who were mostly small subsistence farmers, resorted to consuming home-produced rice and wheat as a coping strategy. This is in line with evidence reported from other parts of the world which find that households rely on subsistence agriculture to insure against food price risk. Results of this study demonstrate that such a strategy probably depends upon the scale of production, the opportunity cost of consuming homegrown food, and the availability of cheaper substitutes.

REFERENCES

Abbott, P. C. (2011) Export restrictions as stabilization responses to food crisis. *American Journal of Agricultural Economics*, 94(2):428–434.

Aghakouchak, A. Ciach, G., & Habib, E. (2010). Estimation of Tail Dependence Coefficient in Rainfall Accumulation Fields, *Advances in Water Resources*, 33(2010), 1142–1149.

Aksoy, M., and B., Hoekman (2010) *Food Prices and Rural Poverty*. CEPR. https://cepr.org/sites/default/files/geneva_reports/GenevaP212.pdf

Asdrubali, P., Sørensen, B. E., and Yosha, O. (1996) Channels of interstate risk sharing: United States 1963–1990. *The Quarterly Journal of Economics*, 111(4):1081–1110.

Baquedano, F. G. and Liefert,W. M. (2014) Market integration and price transmission in consumer markets of developing countries. *Food Policy*, 44:103–114.

Bellemare, M. F. (2015) Rising food prices, food price volatility, and social unrest. *American Journal of Agricultural Economics*, 97(1): 1–21.

Bellemare, M. F., Fajardo-Gonzalez, J., and Gitter, S. R. (2018) Foods and fads: The welfare impacts of rising quinoa prices in Peru. *World Development*, 112: 163–179.

Bhattacharya, S., Falcao, V. L., and Puri, R. (2017) The public distribution system in India: *Policy evolution and program delivery trends*. https://doi.org/10.1596/978-1-4648-1087-9_ch2

Binswanger-Mkhize, H. P. (2012). Is there too much hype about index-based agricultural insurance? *Journal of Development Studies*, 48(2), 187-200.

Binswanger, H. P. (1980). Attitudes toward risk: Experimental measurement in rural India. *American Journal of Agricultural Economics*, 62(3), 395-407.

Bladimir, C. (2020) Present bias and underinvestment in education? Long-run effects of childhood exposure to booms in Colombia. *Journal of Labor Economics*, 38(4): 1127–65.

Brückner, M., and Ciccone, A. (2010) International commodity prices, growth and the outbreak of civil war in Sub-Saharan Africa. *The Economic Journal*, 120(544): 519-534.

Budd, J. W. (1993) Changing food prices and rural welfare: A nonparametric examination of the Cote d'Ivoire. *Economic Development and Cultural Change*, 41(3): 587-603.

Canova, F. and Ravn, M. O. (1996) International consumption risk sharing. *International Economic Review*, 573–601.

Carter, M., & Barrett, C. (2006). The Economics of Poverty Traps and Persistent Poverty: An Asset-based Approach, *Journal of Development Studies*, 42(2), 178-199.

Carter, M., de Janvry, A., Sadoulet, E., & Sarris, A. (2014). Index-based weather insurance for developing countries: A review of evidence and a set of propositions for up-scaling. *Development Policies Working Paper*, 111.

Ceballos, F., Hernandez, M. A., Minot, N., and Robles, M. (2017) Grain price and volatility transmission from international to domestic markets in developing countries. *World Development*, 94:305–320.

Chantarat, S., Mude, A. G., Barrett, C. B., & Carter, M. R. (2013). Designing index-based livestock insurance for managing asset risk in northern Kenya. *Journal of Risk and Insurance*, 80(1), 205-237.

Clarke D. J. (2016). A Theory of Rational Demand for Index Insurance, American Economic Journal: Microeconomics, *American Economic Association*, 8(1), 283-306.

Clarke, D. J., Clarke, D., Mahul, O., Rao, K. N., & Verma, N. (2012). Weather based crop insurance in India.

Cogneau, D., and R. Jedwab. (2012) Commodity price shocks and child outcomes: The 1990 cocoa crisis in Côte d'Ivoire. *Economic Development and Cultural Change* 60 (3): 507–34.

Cole, S. A., Gine, X., Tobacman, J., Topalova, P., Townsend, R. M., & Vickery, J. (2013). Barriers to Household Risk Management: Evidence from India, *American Economic Journal: Applied Economics*, 5(1) 104–135.

Cole, S. A., Stein, D., & Tobacman, J. (2014). Dynamics of Demand for Index Insurance: Evidence from a Long-Run Field Experiment, *American Economic Review: Papers & Proceeding*s, 104(5), 284–290.

Crucini, M. J. (1999) On international and national dimensions of risk sharing. *Review of Economics and Statistics*, 81(1):73–84.

Dawe, D. and Slayton, T. (2011) The world rice market in 2007-08. In Prakash, A., editor, *Safeguarding Food Security in Volatile Global Markets*, Chapter 9, pages 164–82. Food and Agriculture Organization of the United Nations, Rome.

Dawe, D., Morales-Opazo, C., Balie, J., and Pierre, G. (2015) How much have domestic food prices increased in the new era of higher food prices? *Global Food Security*, 5:1–10.

De Hoyos, R. E. and Medvedev, D. (2011) Poverty effects of higher food prices: A global perspective. *Review of Development Economics*, 15(3): 387–402.

De Janvry, A. and Sadoulet, E. (2010) The global food crisis and Guatemala: What crisis and for whom? *World Development*, 38(9):1328–1339.

Deaton, A. (1989) Rice prices and income distribution in Thailand: A non-parametric analysis. *The Economic Journal*, 99(395): 1–37.

Dercon, S., & Christiaensen, L. (2011). Consumption Risk, Technology Adoption and Poverty Traps: Evidence from Ethiopia, *Journal of Development Economics,* 96(2), 159-173.

Dercon, S., Hill, R. V., Daniel, C., Outes-Leon, I., & Seyoum Taffesse, A. (2014). Offering Rainfall Insurance to Informal Insurance Groups: Evidence from a Field Experiment in Ethiopia, *Journal of Development Economics*, 106(1), 132-143.

Desai, S. (2015) Public distribution system: More people rely on the PDS than ever before. *India Human Development Survey Research Brief*. https://idl-bnc-idrc.dspacedirect.org/handle/10625/53913

Desai, S. and Vanneman, R. (2010) National Council of Applied Economic Research, New Delhi. India Human Development Survey (IHDS), 2005. *Ann Arbor, MI: Interuniversity Consortium for Political and Social Research*.

Desai, S. and Vanneman, R. (2018) National Council of Applied Economic Research, New Delhi. India Human Development Survey (IHDS), 2012. *Ann*

Arbor, MI: Interuniversity Consortium for Political and Social Research, University of Michigan.

Dorosh, P. A. (2001) Trade liberalization and national food security: Rice trade between Bangladesh and India. *World Development*, 29(4):673–689.

Dreze, Jean. (2011) The cash mantra. Indian Express. https://indianexpress.com/article/opinion/columns/the-cash-mantra/

Du, X., Hennessy, D. A., Feng, H., & Arora, G. (2018). Land resilience and tail dependence among crop yield distributions. *American Journal of Agricultural Economics*, 100(3), 809-828.

Dube, O., and Vargas, J. F. (2013) Commodity price shocks and civil conflict: Evidence from Colombia. *The Review of Economic Studies*, 80(4): 1384-1421.

Easterly, W., and Fischer, S. (2001) Inflation and the poor. *Journal of Money, Credit and Banking*, 160-178.

Edmonds, E. V., and Pavcnik, N. (2005) The effect of trade liberalization on child labor. *Journal of International Economics*, 65(2): 401–419.

Elabed, G., & Carter, M. R. (2015) Compound Risk Aversion, Ambiguity and the Willingness to Pay for Microinsurance, *Journal of Economic Behavior and Organization*, 118(2015), 150–166.

FAOSTAT. (2014) *Food Balance Sheets*. URL http://www.fao.org/faostat.

Gadenne, L. (2020) Can rationing increase welfare? Theory and an application to India's ration shop system. *American Economic Journal: Economic Policy*, 12(4): 144-77.

Gadenne, L., Norris, S., Singhal, M., and Sukhtankar, S. (2021) *In-kind transfers as insurance*. National Bureau of Economic Research.

Gilbert, C. L. (2011) Grains price pass-through, 2005-09. In Prakash, A., editor, *Safeguarding Food Security in Volatile Global Markets*, Chapter 7, pages 127–148. Food and Agriculture Organization of the United Nations, Rome.

Gilbert, C. L. and Morgan, C. W. (2010) Food price volatility. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 365(1554):3023–3034.

Gine, X., Townsend, R. M., & Vickery, J. I., (2008). Patterns of Rainfall Insurance Participation in Rural India, *World Bank Economic Review*, 22(3), 539–66.

Giordani, P. E., Rocha, N., and Ruta, M. (2016) Food prices and the multiplier effect of trade policy. *Journal of International Economic*s, 101:102–122.

Goodwin, B. K. (2001). Problems with Market Insurance in Agriculture. *American Journal of Agricultural Economics*, 83(3), 643–649.

Goodwin, B. K., & Hungerford, A. (2014). Copula-based models of systemic risk in US agriculture: implications for crop insurance and reinsurance contracts. *American Journal of Agricultural Economics*, 97(3), 879-896.

Gouel, C. (2013) Optimal food price stabilisation policy. *European Economic Review*, 57:118–134.

Gulati, A. and Narayanan, S. (2003) Rice trade liberalisation and poverty. *Economic and Political Weekly*, 38(1): 45–51.

Headey, D. (2011) Rethinking the global food crisis: The role of trade shocks. *Food Policy*, 36 (2):136–146.

Headey, D. (2018) Food prices and poverty. *The World Bank Economic Review*, 32(3):676–691.

Headey, D., and Fan, S. (2008) Anatomy of a crisis: The causes and consequences of surging food prices. *Agricultural Economics,* 39: 375-391.

Hill, R. V., Robles, M., & Ceballos, F. (2016). Demand for a Simple Weather Insurance Product in India: Theory and Evidence, *American Journal of Agricultural Economics,* 1-21.

IMF, (2008) Food and fuel prices: Recent developments, macroeconomic impact, and policy responses. Fiscal Affairs, Policy Development and Review, and Research Departments, International Monetary Fund, Washington, DC.

Ivanic, M. and Martin, W. (2008) Implications of higher global food prices for poverty in low income countries. *Agricultural Economics*, 39(s1): 405–416.

Ivanic, M. and Martin,W. (2014) Short-and long-run impacts of food price changes on poverty. Policy Research Working Paper; No. 7011. World Bank, Washington, DC.

Ivanic, M., Martin, W., and Zaman, H. (2012) Estimating the short-run poverty impacts of the 2010–11 surge in food prices. *World Development*, 40(11): 2302–2317.

Jacoby, H. G. (2016) Food prices, wages, and welfare in rural India. *Economic Inquiry*, 54(1): 159–176.

Jensen, N. D., & Barrett, C. B. (2017). Agricultural Index Insurance for Development. *Applied Economic Perspectives and Policy*, 39(2), 199-219.

Jensen, N. D., Barrett, C. B., & Mude, A. G. (2016). Index insurance quality and basis risk: evidence from northern Kenya. *American Journal of Agricultural Economics*, 98(5), 1450-1469.

Jha, S., Kubo, K., and Ramaswami, B. (2016) International trade and risk sharing in the global rice market: The impact of foreign and domestic supply shocks. *Asian Development Review*, 33(1):162–182.

Kamola, I. (2007) The global coffee economy and the production of genocide in Rwanda, Third World Quarterly, 28(3): 571–592.

Kebede, H. A. (2021) The passthrough of international commodity price shocks to producers' welfare: Evidence from Ethiopian coffee farmers. *The World Bank Economic Review*.

Knudsen, O., and Nash, J. (1990) Domestic price stabilization schemes in developing countries, Economic Development and Cultural Change, 38(3), 539-58.

Kose, M. A., Prasad, E. S., and Terrones, M. E. (2009) Does financial globalization promote risk sharing? *Journal of Development Economics,* 89(2):258–270.

Kotwal, A., Murugkar, M., and Ramaswami, B. (2011) PDS forever? *Economic and Political Weekly*, 46(21): 72-76.

Krishna, R., Haykin, S., and Chhibber, A. (1983) *Policy modeling of a dual grain market: The case of wheat in India.* International Food Policy Research Institute.

Krishnamurthy, P., Pathania, V., and Tandon, S. (2017) Food price subsidies and nutrition: Evidence from state reforms to India's public distribution system. Economic Development and Cultural Change, 66(1): 55-90.

Kruger, D. (2007) Coffee production effects on child labor and schooling in rural Brazil. *Journal of Development Economics*, 82 (2): 448–63.

Lewis, K. K. (1996) What can explain the apparent lack of international consumption risk sharing? *Journal of Political Economy*, 104(2):267–297.

Martin, W. and Anderson, K. (2011) Export restrictions and price insulation during commodity price booms. *American Journal of Agricultural Economics*, 94(2):422–427.

Miller, G., and B. P. Urdinola. (2010) Cyclicality, mortality, and the value of time: The case of coffee price fluctuations and child survival in Colombia. *Journal of Political Economy*, 118(1): 113–55.

Minot, N. (2011) *Transmission of world food price changes to markets in Sub-Saharan Africa*. International Food Policy Research Institute.

Miranda, M. J. (1991). Area-yield crop insurance reconsidered. *American Journal of Agricultural Economics*, 73(2), 233-242.

Mishra, P., and Roy, D. (2012) Explaining inflation in India: The role of food prices. In *India Policy Forum* (Vol. 8, No. 1, pp. 139-224). New Delhi, India: National Council of Applied Economic Research.

Mitra, S. and Josling, T. (2009) Agricultural export restrictions: Welfare implications and trade disciplines. *International Food & Agricultural Trade Policy Council (IPC)*, pages 1–37.

Mobarak, A. M., & Rosenzweig, M. (2013). Informal Risk Sharing, Index Insurance, and Risk Taking in Developing Countries, *American Economic Review*, 103(3), 375–80.

Morsink, K., Clarke, D., & Mapfumo, S. (2016). How to measure whether index insurance provides reliable protection.

Mundlak, Y. and Larson, D. F. (1992) On the transmission of world agricultural prices. *The World Bank Economic Review*, 6(3):399–422.

Narayanan, S., and Gerber, N. (2017) Social safety nets for food and nutrition security in India. *Global Food Security*, 15: 65-76.

Narayanan, S., Naraparaju, K., and Gerber, N. (2019) Synergies in Social Protection: Impacts of India's MGNREGA and Public Distribution System on the health and nutrition of Women and Children. *Available at SSRN 3513358*.

Patton, A. (2013). Copula methods for forecasting multivariate time series. *Handbook of Economic Forecasting,* 2, 899-960.

Ramaswami, B., & Roe, T. L. (2004). Aggregation in area-yield crop insurance: the linear additive model. *American Journal of Agricultural Economics*, 86(2), 420-431.

Ravallion, M. (1990) Rural welfare effects of food price changes under induced wage responses: Theory and evidence for Bangladesh. *Oxford Economic Papers*, 42(3): 574–585.

Robles, M., Torero, M., and Cuesta, J. (2010) Understanding the impact of high food prices in Latin America. *Economia*, 10(2):117–164.

Rosenzweig, M R., and Binswanger, H. P. (1993). Wealth, Weather Risk and the Profitability of Agricultural Investment, Economic Journal, 103(416), 56–78.

Rudolf, R. (2019) The impact of maize price shocks on household food security: Panel evidence from Tanzania. *Food Policy*, 85: 40-54.

Slayton, T. (2009) *Rice crisis forensics: How Asian governments carelessly set the world rice market on fire*. Center for Global Development working paper.

Sørensen, B. E. and Yosha, O. (1998) International risk sharing and European monetary unification. *Journal of International Economics*, 45(2):211–238

Swinnen, J., (2010) The right price of food: Reflections on the political economy of policy analysis and communication. LICOS Discussion Papers 25910.

Tandon, S. (2015) Coping strategies in response to the world food price crisis: Evidence from India.

Timmer, C. P. (2008) *Causes of high food prices*. Technical report, ADB Economics Working Paper Series.

Townsend, R. M. (1994). Risk and Insurance in Village India. Econometrica, 62(3), 539-591.

Valdes, A. (1981) *Food Security for Developing Countries*. Westview Press.

Van Campenhout, B., Pauw, K., and Minot, N. (2018) The impact of food price shocks in Uganda: first-order effects versus general-equilibrium consequences. *European Review of Agricultural Economics*, 45(5): 783-807.

Wodon, Q. and Zaman, H. (2010) Higher food prices in Sub-Saharan Africa: Poverty impact and policy responses. *The World Bank Research Observer*, 25(1): 157–176.

Wodon, Q. T., Tsimpo, C., Backiny-Yetna, P., Joseph, G., Adoho, F., and Coulombe, H. (2008) Potential impact of higher food prices on poverty: Summary estimates for a dozen west and central African countries. *World Bank Policy Research Working Paper*, (4745).

World Bank, (2008) Addressing the food crisis: The need for rapid and coordinated action. Background paper for the Group of Eight Meeting of Finance Ministers, Osaka, June 13-14, 2008. The World Bank, Washington, DC.

Wright, B. D. (2011) The economics of grain price volatility. *Applied Economic Perspectives and Policy*, 33(1):32–58.

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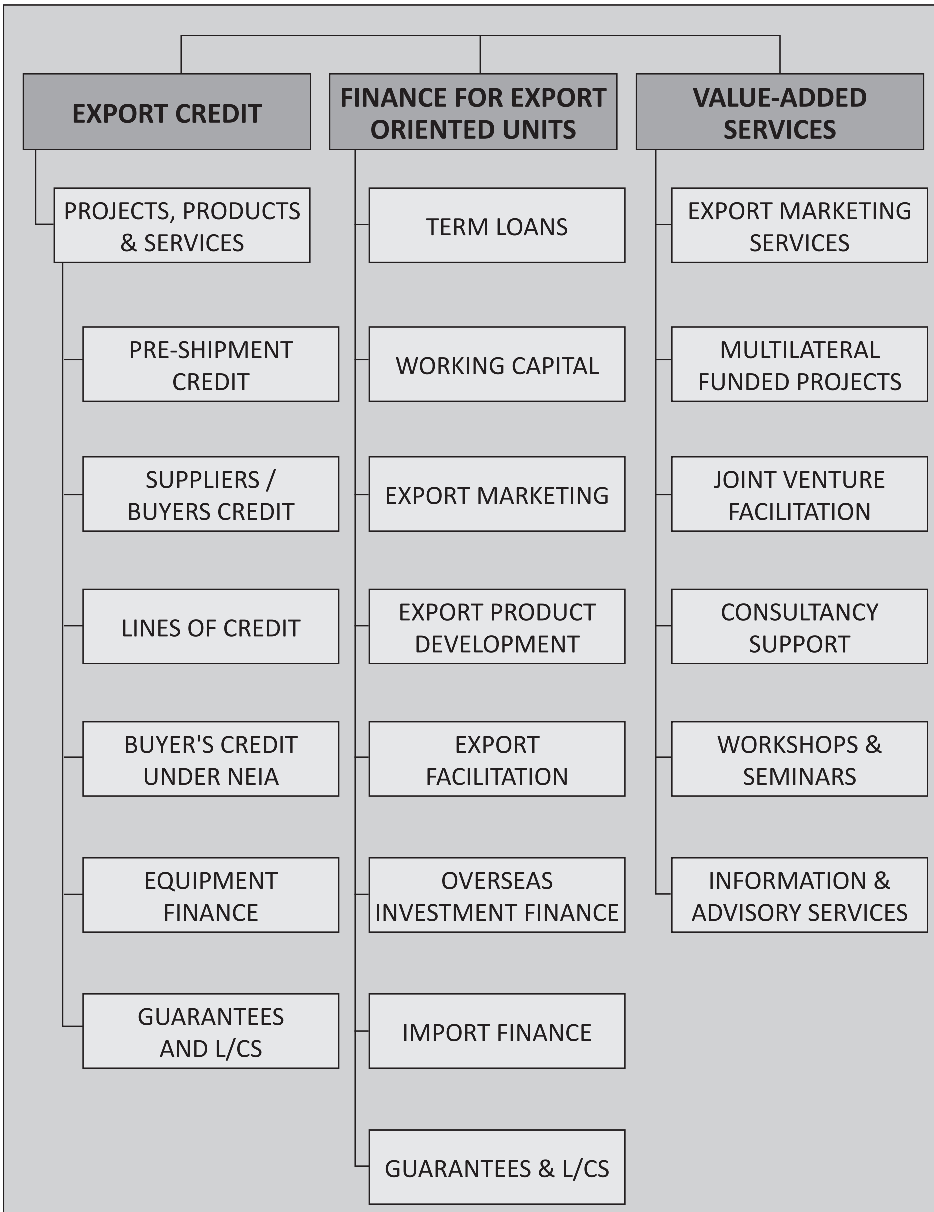

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