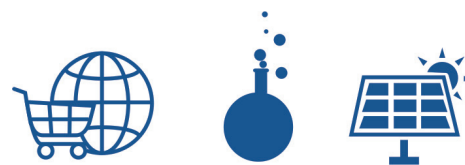**India Exim Bank**

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RESEARCH BRIEF No. 140

Essays on Risk, Insurance and Welfare

Export-Import Bank of India (India Exim Bank) instituted the BRICS Economic Research Annual Citation (BRICS Citation) in 2016. The objective of the Citation is to promote advanced doctoral research in international economics, trade, development and related financing, by nationals of any of the five member nations of BRICS, from any University/ educational institution globally. This study is based on the doctoral dissertation titled "Essays on Risk, Insurance and Welfare" selected as the winning entry for the India Exim Bank BRICS Economic Research Annual Citation (BRICS Citation) 2023, written by Dr. Digvijay Singh Negi, currently Fulbright-Nehru Postdoctoral Fellow, Cornell University, USA. Dr. Negi received his doctoral degree in 2018 from the Indian Statistical Institute, India.

1. Introduction

Countries, communities, or households are exposed to a variety of shocks. In the context of developing countries, however, weather shocks and rainfall failures take special significance as much of the population is either directly or indirectly engaged in agricultural activities. Given that future projections of climate predict a greater likelihood of erratic and unpredictable weather patterns, rural communities in developing countries become especially vulnerable to future climate changes. Weather shocks are well known to destroy rural livelihood but can also be of consequence for food production at the national level. Therefore, economists and policymakers have had a special interest in studying the role of various mechanisms which can mitigate the consequences of such shocks. In the context of global food markets and agriculture, the present study discusses two mechanisms through which insurance from shocks can be achieved viz. trade and formal insurance markets.

The first section in this study examines the role of trade in global food markets in insulating food consumption from country-specific food production shocks. The possibility of trade as insurance arises from the idea that, as long as the production shock is local and only affects a particular country, trade across countries can facilitate risk sharing. The second section looks at the design risk in rainfall-based index insurance contracts in India and studies its implications for optimal demand for rainfall insurance. Finally, the last section studies the distributional implications of food price shocks for net food producers and consumer households in India.

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. To what extent then trade in global food markets be able to insure country-specific output fluctuations? While global food trade may alleviate food security concerns during a production shortfall, rural livelihoods can be protected with formal insurance products. What is the best way to design an index-based crop insurance contract such that the coverage of farm-specific losses is maximized or basis risk is minimized? Finally, who gains and who loses from high food prices? The three studies in this research study pose these questions directly relevant to global agriculture and food security.

2. 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 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. 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. Production variability of Rice, Wheat, and Maize: 1961-2013
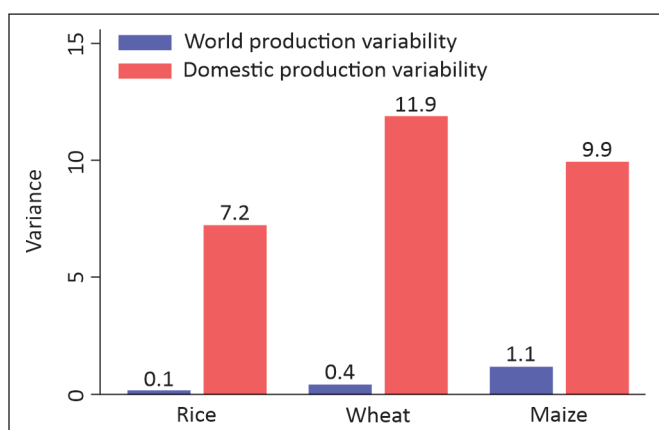
Note: Estimates based on the food balance sheet data from the Food and Agriculture Organization's (FAO) database.

The primary objective of this study is to examine the performance of world markets for grains (maize, rice, and wheat) in production risk-sharing. The study finds that global food markets are not able to share production risk efficiently. However, the global wheat market comes very close to efficient risk-sharing. 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. Further, richer countries are able to achieve higher consumption insurance from production fluctuations than poorer countries.

3. Lower Tail Dependence, Basis Risk and the Demand for Weather Insurance

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 insurance to 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 study examines how rainfall insurance contracts in India can be designed to reduce basis risk. The study exploits the idea that the joint distribution of rainfall and output might be characterized by tail dependence. Figure 2 shows the statistical association between district-level crop yields and rainfall for nine major crops in India. As can be observed from the figure, all nine crops exhibit a higher association between crop yield and rainfall for extreme shortfalls. This means that if rainfall in a year is extremely low, crop yield losses are highly likely and are widespread.

Figure 2. Estimated association between district-level crop yields and rainfalls
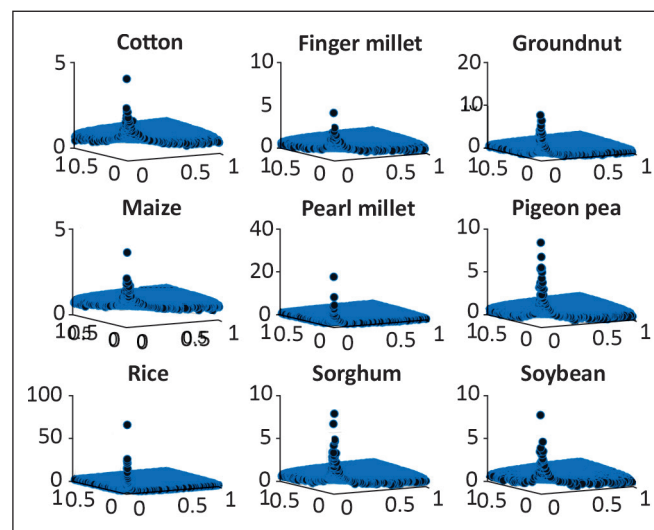
The major implication of tail dependence is that the value (to farmers) of index-based insurance relative to actuarial cost is highest for insurance against extreme or catastrophic losses (of the index) than for insurance against all losses. In simpler words, basis risk is the least for large deviations of the index. The study finds 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 (Figure 2). This implies that the associations between yield losses and index losses are stronger for large deviations than for small deviations. Alternatively, 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.

4. Global Food Price Surge, In-Kind Transfers, and Household Welfare

Rising food prices are a concern globally. As exposure to high food prices is proportional to its budget share in household expenditure, the worst affected population groups are the 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.

This study examines the impact of rising global food prices for rice and wheat during 2007/08 on the welfare of Indian households. In general, an increase in food prices will affect the welfare of both consumers and producers, but in different directions. Consumers will lose as higher food prices will make food less affordable and reduce the real value of income. Producers, however, stand to 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. In addition, higher food prices may also lead to higher wages and a greater derived demand for labor, inputs, and other commodities locally.

Figure 3. Changes in poverty rates of net consumers and producers of food between 2005 and 2012
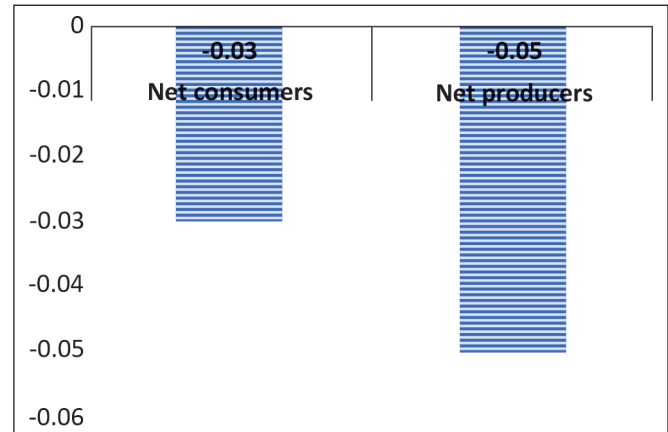
Notes. Figure shows the reduction in the proportion of poor between 2005 and 2012 for the net rice and wheat producing and consuming households. Estimates based on the Indian Human Development Surveys.

Figure 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. The study also finds that high global rice and wheat prices led to an increase in household consumption expenditure and the share of non-food for rice and wheat cultivating households. Moreover, 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. 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 the study observes a decline in the consumption of rice and wheat for net consumer households, they were able to maintain their total calorie intakes by consuming cheaper coarse cereals. These coping strategies were enough to ensure non-rising total food expenditures for the households.

5. Conclusion

Findings and lessons emerging from the three studies are directly relevant to BRICS nations as well as other developing countries.

The first study finds that global food markets are not able to share risk efficiently. This, however, would not be a surprise to observers of world food markets. The finding, though, that the maize market performs just as poorly as the rice market is unexpected. Another noteworthy finding is that both trade and storage provide insurance for all three markets. In an ideal world with no trade costs, 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. We see similar results in the wheat and maize markets. Improving risk sharing for poor countries can play a vital role in achieving food security. This study provides grounds for such a discussion.

The second study finds 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. Moreover, 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. Finally, 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.

The findings from the third study 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. However, 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 in-kind 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. The study finds that such a strategy depends upon the scale of production, the opportunity cost of consuming homegrown food, and the availability of cheaper substitutes.

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