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International Trade and Risk Sharing in the Global Rice Market: The Impact of Foreign and Domestic Supply Shocks.

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ABSTRACT

In recent years, rising food prices have returned as a concern for policy makers especially in developing countries. In this context, this paper examines how supply shocks, both domestic and foreign, have mattered to imports and consumption in the global rice market over 1960–2010. Such an investigation is important in assessing the role of trade in compensating for domestic shocks. If shortages lead countries to impose trade restrictions, then trade may not be allowed to play an important role in stabilizing consumption. The existing literature has highlighted the importance of these policy shocks in the world rice market and how they have worked to increase the volatility of prices and trade flows. Although trade cannot be expected to play a strong role when the majorproducing and consuming countries are simultaneously hit by negative yield shocks, such a scenario obtains in only 3% of cases. However, we also find that consumption fails to be stabilized even when domestic shocks are negative and foreign shocks are positive; but imports do peak. Thus, while trade does help in coping with domestic risks, it is unable to achieve full risk sharing. Therefore, no matter what are the foreign shocks, the principal concern is to stabilize consumption when hit by negative domestic yield shocks. The frequency of such shocks is about 12%. This brings into play domestic responses, and we find that domestic stocks have been important in stabilizing consumption. The reliance on domestic policies has in turn kept the rice market thin.

Keywords: food prices, risk sharing, rice market, international trade, supply shocks

JEL Classification: F14, Q17

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I. INTRODUCTION

In recent years, an old concern has resurfaced—that of rising food prices. After the food crisis in the mid-1970s, the world enjoyed declining to stable real prices until the mid-1990s. In 1995–1996, there was a spike in prices followed by a return to the long-term trend. From the early part of the 2000s, however, prices have crept upwards, culminating in sharp rises during 2006–2007 to 2008–2009.

Palm oil, rice, and wheat prices doubled in 2007–2008 relative to 1999–2000. Wheat and maize prices increased by more than 75% (Gilbert 2011).[2] What was striking was that the price spikes happened in a very short time interval. In nominal terms, world maize prices increased by 54% from August 2006 to February 2007 followed by an increase in world wheat prices of 125% from May 2007 to March 2008. The most dramatic increase occurred in rice prices. From April 2001 to September 2007, the gradual upward drift saw the price of Thai 100% B rice doubled from $170 per ton to $335 per ton, amounting to a 67% increase relative to the United States Consumer Price Index. But between October 2007 and April 2008, the price tripled to over $1,000 per ton (Dawe and Slayton 2011). These trends are evident in Figure 1 that plots rice prices deflated by the US consumer price index for the period 1980-2015.

The food price spikes of 2007–2008 have renewed old debates about the efficacy and desirability of price stabilization measures. Economists have long argued that storage-based price stabilization is expensive and, in some instances, ineffective. On the other hand, opening up the economy to trade can be effective in insulating against severe domestic shocks. The food price crisis of 2007–2008, however, planted doubts in policy makers about the reliability of world markets in times of need. Several policy studies have concluded that some public grain reserves are necessary. Price stabilization pursued through public stocks cannot be effective, however, when borders are open. So some restriction of trade would also be necessary.

In the context of this debate, the goal of this paper is to examine how supply shocks, both domestic and foreign, have mattered to imports and consumption over the period 1960– 2010 in the global rice market. In autarkic economies, domestic supply shocks drive consumption shocks as well. In countries open to trade, and when trade functions well, domestic consumption depends on both domestic and foreign supply shocks. In particular, compared to autarky, domestic shocks would matter less because of access to world markets. For small open economies, domestic shocks should not matter at all.

These ideal outcomes may not be obtained, however, if policies impede trade. Rising prices often provoke governments to put in place policies that buffer the impact. When they take the form of trade restrictions, world trade may shrink; thus, countries might not have access to world supplies to compensate for adverse domestic shocks. Rice is commonly considered the archetype of an agricultural staple that is subject to such endogenous policy shocks. Hence, we chose to study the impact of domestic and foreign supply shocks on rice imports and consumption.

The outline of this paper is as follows. The next two sections offer a selective survey of the literature on the global rice market with respect to endogenous policy shocks and the reliability of rice trade. Section IV is a descriptive account of the global rice trade and the trade interventions of major exporters. Section V offers a statistical analysis of the impact of

[2]Gilbert reports these price changes after deflating the nominal prices by the US Producer Price Index.

exogenous domestic and foreign supply shocks on imports and consumption. Section VIextends this to include the policy variable of domestic and foreign stocks. Concluding remarks are gathered in Section VII.

II. THE RICE MARKET AND ENDOGENOUS SHOCKS

The role of policy responses in provoking and exaggerating price spikes has been particularly highlighted by the global rice market. A review of the literature tells us that it is the rice market that is particularly subject to endogenous policy shocks. Unlike wheat and maize, a relatively small proportion of world rice production (9%) enters international trade. Moreover, wheat and maize trade is driven by surpluses from rich and large land-abundant countries such as Argentina, Australia, Canada, and the United States (US). In the case of wheat, Australia, Canada, and the US export more than 50% of their production. The biggest rice exporter, Thailand, exports close to 40% of its output. However, its share in world rice output is less than 5%. India is emerging as a strong competitor to Thailand, vying for the position of the top exporter. Yet, in 2014-15, despite a record increase amounting to a little over one-fifthof world production,India exported barely 10% of its output. Offloading its huge stockpile,India may well turn out to be the "swing" actor in the rice market.

Apart from India, other large rice-producing countries such as Bangladesh, the People's Republic of China (PRC), and Indonesia are either deficient, or at best, have small surpluses relative to consumption. All of these countries have poor populations that are severely affected when rice prices rise. Due to such food security concerns, these countries will likely reduce their net supply to the world markets in times of crisis. This can take the form of export restrictions for exporters, or reductions in import tariffs. Following the self-sufficiency stance much of Asia is piling up stocks as well. In either case, the attempts of these countries to increase their share of world consumptioncan raise world prices. Thus, policies directed toward insulating domestic markets magnify international price volatility when all countries attempt to insulate their respective domestic markets at the same time (Abbot 2011; Martin and Anderson 2011).

During the crisis of 2007–2008, many scholars argued that it was likely that the spike in rice prices was due not to crop failure or low stocks but to policy measures put in place by panicked governments. Writing as early as October 2008, Timmer (2008) argued that the underlying causes for the rise in rice prices are different from those in wheat and maize prices. Low stocks, crop failure, or financial speculation were not plausible factors behind the price increases in rice in 2007–2008. Nor could these increases be attributed in a straightforward manner to the rise in wheat or maize prices because substitution in consumption among these grains is limited. Rather, the spike must be seen as due to export restrictions by some of the major exporting countries, which induced panic buying by importers such as the Philippines; and storage-driven because of the hoarding instincts of governments and other agents. This has been echoed by others (Dawe and Slayton 2011; Gilbert and Morgan 2010; Wright 2011).

Martin and Anderson (2011) estimate that more than 45% of the explained change in international rice price during 2005–2008 was due to export restrictions (compared to 29% for wheat). Using a more-comprehensive global economy-wide model, Jensen and Anderson (2014) estimate the impact of such price-insulating policiesto be aboutone-thirdof the world price rise. If anything, these estimates are surprising in that endogenous shocks account for only one-third to half of the rice price increase when most of the literature seems to argue that it is significantly driven by policy shocks. The hypothesis that export policies contribute to global price volatility

has also been tested by Giordani, Rocha, and Ruta (2012). Using a data set on trade measures relating to the food sector, they find that the probability that a country imposes a new export restriction is positively associated with the global restrictions on the product (i.e. the share of international trade covered by export restrictions). Furthermore, for 2008–2010, they estimate that a 1% surge in the share of trade covered by export restrictions is associated with a 1.1% increase in international food prices.

III. THE RELIABILITY OF RICE TRADE AND MARKETS

As mentioned earlier, in an integrated global market, trade provides a means for price stabilization without costly investment in commodity stocks. This has been the view of many economists. However, this does not take into account the possibility of government interventions such as market-insulating policies. If exporters restrict their supply fearing a shortfall, importers are deprived of food just when they need it the most. Such an experience may well persuade importers that food trade is unreliable and that they should increase self-sufficiency by investing in domestic stocks and raising production,even irrespective of thecosts.

Gilbert (2011) argues that it is the rice market and rice trade that are unreliable among those of the major grains. In an earlier work (Gilbert 2010), he showed that a commonly quoted world rice price—the spot price in Bangkok—follows various national prices rather than the other way around (as it is for maize). As it is the rice market that "functions least well," Gilbert (2011) argues for a pragmatic approach where it is recognized that low-income countries "can probably rely on being able to import additional maize or wheat if this proves necessary, but may justifiably be worried about being able to do so for rice." He argues, "[T]his points towards the need for contingency arrangements for rice—either food security stocks, or formal trade agreements with rice exporters or, where this is feasible, a move towards rice self-sufficiency."

A related point is that the rice market has been seen to be somewhat disconnected from the markets for other cereals. Shocks to rice supply and demand are not highly correlated with those to other grains. Global futures markets are irrelevant to rice and the crop does not have a use as a biofuel (Dawe and Slayton 2011). It is in this sense that Gilbert and Morgan (2010) regard the rice price spike in 2007–2008 as "peculiar and in some sense pre-modern." Unlike that of other grains, the price volatility in this market does not always depend on the fundamentals of demand and supply shocks and price elasticities. The particular problem of the rice market is the tendency of important trading countries to shield themselves from external shocks. Hence, "rice is different" and the future course of volatility will depend on how the international community addresses the particular problems of this market (Gilbert and Morgan 2011).

IV. GLOBAL RICE TRADE

Imagine a two-country trade model where one of the countries is producing rice. Imagine also that there is no government intervention in either exports or imports. The production of rice is subject to stochastic yield shocks. It is expected then that the higher the yield, the greater the volume of rice that is traded. Figure 2 plots the proportion of world output that is exported against world yields for 1960–2011. The world yield is the production share weighted average of individual country yields. For world yields up to 3 tons per hectare (ha), world exports fluctuate at around 4% of world output without any trend. Beyond that, in the range of 3 to 3.5 tons per ha, the ratio of exports to world output fluctuates at around a higher level of 7%. A closer look shows that the observations in the right half of the graph, involving world yields of more than 3 tons per ha, belong to the period beginning 1994.

Table 1 shows that the average export–output ratio in 1994–2011 was 7.16%—which represents an increase of 87% over the average value in the pre-1994 period. The discrete jump in the export–output ratio is primarily due to increased rice exports from India. Up to the early 1990s, quantitative restrictions clamped down on non-basmati rice exports from India. The removal of these restrictions in 1993 and 1994 led to non-basmati rice exports of 4.5 million tons from less than a

million tons in the early 1990s (Kubo 2011). The other factor behind the higher export–output ratio is the rise of Viet Nam as a major rice exporter. This has been a more gradual process starting from the country's reentry into the world market in 1989. Export liberalization in India and Viet Nam (the leading exporters next to Thailand), therefore, explains why the world rice market grew relatively "thicker" in the 1990s.

It could, however, be argued that a common trend may be responsible for the correlation between world yield and the export-output ratio. Indeed, if the export-output ratio is regressed on world yield and a time trend (whether linear or quadratic), the coefficient of world yield while still significant becomes negative. While this means that deviations from the trend are negatively correlated, the presence of a common trend is suggestive of the positive association between the two variables.

However, from Table 1, note that the pre-1994 period is characterized by low variability in the export–output ratio even as yields doubled, while the post-1994 period is characterized by high variability in the export–output ratio even as yields have remained in a narrow range of 3–3.5 tons per ha. The coefficient of variation of the export–output ratio in 1994–2011 is twice that in the pre-1994 period. Thus, it seems that while world markets have been more open since the 1990s, policy interventions have made them more unstable as well.[3]It could be that limited reforms and longer market access allowed by the Uruguay Round helped developing countries stabilize domestic prices while world prices became more volatile. Wailes (2005) reports coefficientof variation of domestic rice prices of 26% for Indonesia, 37% for China and 43% for India over 15 to 20 yearsprior to 2005.Much of the trade expansion during that period was on account of surging rice imports by Asian and African countries supported by abundant supplies in major exporting countries (Calpe 2006). However, following the food price crisis, India and Viet Nam were among the first countries to impose export restrictions in 2007. More generally, both these countries have domestic concerns that spill over into international markets. This was evident even prior to the 2007 crisis.

In India, the principal domestic policy imperative is for the government to procure enough supplies to maintain its distribution channel of subsidized rice and wheat. A failure to restrict procurement left the country with an accumulation of massive stocks. In April 2001, this amounted to 51 million tons of grain, including 25 million tons of rice that prompted the government to sell the grain at subsidized prices forexports. Global price effects were thus a byproduct of domestic food security policy of India, a large trader (Jha 2011). The subsequent unloading of stocks in the international market led to rising exports and the prolonged stagnation of rice prices in the global market (Kubo 2011). Such large-scale dumping of government stocks on the world market ceased after 2004. By 2005, rice stocks in India had fallen to 13 million tons and more significantly, wheat stocks had dropped to 2 million tons. A subsequent shortfall in wheat procurement that coincided with wheat crop failures in the rest of the world panicked the government into wheat imports and a determination not to allow similar shortfalls in rice procurement. So after dumping rice stocks into the world market in the early 2000s, the government moved to restrict and finally ban rice exports in the late 2000s. With the recovery of rice and wheat stocks, the government once again lifted export restrictions.

Viet Nam has always maintained tight control over rice exports. Initially this took the form of export quotas for registered companies. These were later abolished, and now the government

[3]Note that higher variability in the export-output ratio could also be because of greater yield instability. However, this does not appear to be the case. While mean world yields increase from 2.16 tons per hectare in the first period to a little over 3 tons per hectare in the second period, the coefficient of variation drops from 21% to 7.4% between the periods.

suspends rice exports once the total reaches the targeted level. In 2007, this happened routinely according to the export target of that year. In 2008, faced with rising domestic prices, the government did not allow new export contracts until July of that year. As in India, concern over the domestic availability of rice prompts the government to tightly monitor export volumes. However, there is a difference as well: India's exports are less than 5% of its consumption, while for VietNam, they amount to more than 30% of the country's consumption. Global sales are more important for Viet Nam—correspondingly, their regulation has been more predictable and more sensitive to the interests of exporters.

V. THE IMPACT OF EXOGENOUS SHOCKS ON IMPORTS AND CONSUMPTION

A systematic relationship between world yields and global rice trade is not evident in Figure 2. Within a two-country model, it would be realistic to assume that both countries produce rice. In this case, in a model of free trade, the amount of rice traded would depend on both domestic yield shocks as well as foreign shocks. For instance, it is expected that importing countries would decrease imports in response to positive domestic yield shocks and increase imports when there is a positive yield shock in the foreign country. As imports feed into consumption, we can also consider the consequences for this indicator of economic welfare. For both countries, consumption is expected to be positively related to both domestic and foreign yield shocks. In the extreme and unrealistic case of perfectly integrated markets, the source of the yield shock would not matter. A weaker hypothesis is that consumption depends positively on both domestic and foreign yield shocks. We now test these hypotheses.

Our data set on country production, area, and stocks is drawn from the US Department of Agriculture. To compute exogenous shocks, we smooth the yield series using the Holt-Winters double exponential method. The deviation of the smoothed series from the observation is defined as the yield shock. This is computed for every country. For every country, we also compute a foreign yield shock, which is the production weighted average of the yield shocks in each of the countries constituting the rest of the world.

To examine the potential of trade, the correlation between domestic yield and foreign yield shocks is worth considering. When there are adverse shocks to both domestic and foreign yields, trade cannot be of much help. To assess the probability of such outcomes, we slice domestic and foreign yield shocks into three categories: a high negative shock, when the shock is one standard deviation below the mean; a high positive shock, when the shock is one standard deviation above the mean; and a mid-range shock, when the yield deviation is within one standard deviation of the mean. This is done for every country and for every year in the sample. The cross-tabulation of these shocks for all countries in the sample is displayed in Table 2. Table 3 contains these cross-tabulations for the major countries that make up world production and trade: Bangladesh, the PRC, India, Indonesia, Iran, Malaysia, Nigeria, Pakistan, the Philippines, Saudi Arabia, Thailand, Viet Nam, and the US.

The results show that in only about 3% of the cases for the entire sample and in about 1% of the cases for the major countries, low domestic yields are accompanied by low foreign yields as well. This means that except for these instances, trade, in principle, should work well in the overwhelming majority of circumstances when domestic production shortfalls are offset to some extent by higher output elsewhere, and vice versa. Yet the puzzle is that rice trade is considered unreliable relative to other grains.

Table 4 is a regression of the first difference in log of imports (as proportion of consumption) on the dummy variables for each of the categories in the cross-tabulations of Tables 2 and 3. The regression is based on the sample of all importing countries. As expected, the percentage change in imports is negative and the greatest in absolute value when the domestic shock is highly positive and the foreign shock is highly negative. This is the case when the demand for imports is at its minimum and the world supply is also at its lowest. Unsurprisingly, percentage change in imports is positive and maximal when the domestic shock is highly negative and when the foreign shock is highly positive. This is the opposite case when world supply is at its maximum and so is the demand for imports. These are instances when trade works in the expected direction.More surprisingly, imports as a proportion of consumption increase even when shocks are negative at home and abroad. In this case, world supply is low but import demand is high.For example, Indonesia imported exceptionally high volumes of rice in 1997 and 1998 to avert the El Niño weather impacts. Similarly, the food price crisis of 2007–2008 led the Philippines to a panic-buying spree to import rice at exorbitant prices. Rice is the single most important food, contributing almost half the calorie intake in these two countries.

There is a clear pattern to the results. The percentage change in imports is less (or negative) when domestic shocks are highly positive; it is high and positive when domestic shocks are highly negative.

To see the cost of highly negative domestic shocks, consider a regression of the log change in rice consumption as a function of the dummy variables representing the combination of highly negative, mid-range, and highly positive domestic and foreign yield shocks. Table 5 shows the results for the entire sample of countries, not just importers. A second specification in the table adds lagged values of the dependent variable as regressors.[4] The impact of the shocks does not vary much between the specifications in terms of the sign and significance of the coefficients.

Reading from the first specification, in the scenario of highly negative domestic and foreign yield shocks, rice consumption declines by 9%.[5] In the scenario of highly negative domestic shocks but highly positive foreign yield shocks, rice consumption declines by 4.5%. The difference in outcomes between these scenarios is a measure of the value of access to world markets. However, consumption declines in all the scenarios involving negative domestic yield shocks. Positive foreign shocks can compensate, but not fully. Earlier, we mentioned that reliance on trade could fail in 2% of the instances when negative shocks affect both domesticand foreign markets. But now it is apparent that rice consumption is vulnerable in all the scenarios involving negative domestic shocks. Such instances occur 12% of the time. Perhaps this is why rice markets are regarded as "unreliable"by policy makers.

The flip side of these results is that rice consumption increases by 10%–13% in all the scenarios involving positive domestic shocks. Most strikingly, the increase in consumption in the scenario of positive domestic and foreign yield shocks (13%) is almost the same as in the scenario of positive domestic and negative foreign yield shocks (12.5%). The failure of trade to redistribute supplies in the latter scenario seems to be the reason why trade is not able to stabilize consumption in countries hit by negative domestic shocks even though world supplies are ample.

[4]Conventional fixed effects estimators (such as the within estimator) are inconsistent when lagged values of the dependent variable are used as regressors. We used the Arellano–Bond estimator which transforms the data into first differences and takes care of the correlation between the error term (first difference of the original error term) and the lagged first differences of the dependent variable by using higher-order lags of the dependent variable as instrumental variables (Arellano and Bond 1991).

[5]This is the difference between the constant term and the coefficient of the dummy variable for highly negative domestic and foreign yield shocks. All regressions have a country-specific fixed effect. As it is additive, it nets out when considering the difference between the base and omitted category of positive domestic and foreign yield shocks and the other categories.

Table 6 is the consumption regression for some of the Asian countries important in the world rice economy: Bangladesh, the PRC, India, Indonesia, the Philippines, and Viet Nam. Pakistan and Thailand are excluded.[6] Once again, the implied rates of consumption change do not vary greatly between the two specifications.

Figure 3 compares the average percentage change in rice consumption in each of the shock scenarios for the Asian sample and for all the other countries in the sample. In the figure, each scenario is denoted as XY, where the domestic shock X = {H, M, L} and the foreign shock Y = {H, M, L} and H, M and L represent the positive, medium range and negative shocks respectively. The horizontal bars represent the percentage change in rice consumption in each of the nine scenarios. For instance, the bars at HH shows that when domestic and foreign yield shocks are both positive, average rice consumption in Asia increases by about 7% while that in non-Asia increases by more than 15%. The percentage changes are derived from Table 6 and a similar regression for the non-Asian countries that is not reported here.[7] In both these regressions, the base category is the HH scenario and therefore the percentage change here is given by the coefficients of this category in the regressions. For the other scenarios, the coefficients of the respective category is added to the coefficient of the dummy for the HH category to obtain the percentage changes in consumption.

The common finding is that rice consumption declines are substantial and comparable in the scenario of negative domestic and foreign shocks. However, Asian countries seem to do better to arrest consumption declines in the other scenarios involving negative domestic yields. The most striking difference involves the positive domestic yield scenarios: the consumption growth in the Asian countries is lower than in the world sample. This could be due to exports or the build-up of domestic stocks. The latter seems more likely because, as in the world sample, the difference in consumption growth between the scenarios of positive and negative foreign shocks (given positive domestic shock) is small. Domestic stocks in turn may have enabled these countries to stabilize consumption when domestic shocks are negative. Yet, even this policy has not been successful when negative domestic shocks are accompanied by negative foreign shocks.Another possible explanation for consumption smoothing could be unregulated rice trade and smuggling across Asian economies such as Indonesia, Kazakhstan, Myanmar, Philippines, PRC, Thailand and Vietnam (IRRWADDY 2015 and Forbes 2008).

[6]Exports as a proportion of consumption are greater than 50% in both these countries. The vulnerability of domestic consumption to yield shocks would not be a major concern here.

[7]Results are based on coefficient estimates for the specification that does not include lagged values of the dependent variable as regressors.

VI. POLICY RESPONSE

It is clear that negative domestic shocks occur when stabilization fails to take place. Access to world markets helps but even when foreign yields are high, consumption declines. These are reduced form results and the outcome of both trade and domestic stabilization policies. To understand how trade and domestic policies modify exogenous shocks, we consider the following regression model for country *j* and year *t*:

$$\ln\left(\frac{C_{jt}}{C_{j,t-1}}\right) = \beta_1 + \beta_{2jt} DY_{jt} + \beta_{3jt} FY_{jt} + \beta_4 DS_{jt} + \beta_5 FS_{jt} + \theta_j + \varepsilon_{jt} \quad (1)$$

where *C* is rice consumption; *DY* and *FY* are domestic and foreign yield shocks; *DS* and *FS* are the domestic and rest-of-the-world stocks, both as proportions of domestic and rest-of-the-world consumption, respectively, at the beginning of year *t*; and θ_j is a country fixed effect. Earlier, we explained how shocks were constructed.

In our data, the policy variable is the level of stocks in each country.[8] Clearly, trade restrictions will have a direct impact on stocks. For each country, we construct a domestic stock variable and a foreign stock, which is an aggregate of the stocks in the rest of the world. We allow the coefficients of domestic and foreign yield shocks to vary with domestic stocks and foreign stocks. In particular,

$$\beta_{2jt} = \gamma_1 + \gamma_2 DS_{jt} + \gamma_3 FS_{jt} \quad (2)$$

and similarly,

$$\beta_{3jt} = \delta_1 + \delta_2 DS_{jt} + \delta_3 FS_{jt} \quad (3)$$

Based on our previous findings, we expect the coefficient on domestic yield, γ_1, to be positive. We also expect the coefficient on foreign yield, δ_1, to be positive but not as large as γ_1. Since domestic stocks are expected to soften the effect of yield shocks, the coefficients γ_2 and δ_2 are expected to be negative. Domestic stocks are also likely to have a direct positive impact on consumption; hence, we expect a positive sign for β_4. It is not clear *a priori* how the level of foreign stocks might affect domestic consumption, either directly or indirectly through its impact on the way yields shocks affect consumption.

The results are presented in Table 8. Both domestic shocks and domestic stocks have a positive impact on the change in consumption, and are statistically significant as well. Foreign yields and foreign stocks are not significant. The interaction term involving domestic shocks and domestic stocks is significantly negative. This shows that domestic policies moderate the impact of domestic shocks.

An alternative specification would replace both the shock variables by the dummies representing negative, mid-range and positive shocks as defined earlier. Both sets of dummies are interacted with domestic and foreign stocks. This allowspolicies to interact with shocks in a nonlinear

[8]The reliability of stocks data is open to question. This caveat applies to the empirical analysis that follows.

manner. This specification is estimated in Table 9. The omitted base category in the table is the combination of mid-range domestic and mid-range foreign yield shock.

Like in the previous specification, foreign stock is not significant either by itself or when interacted with shocks. Relative to the base category, the decline in the growth of rice consumption in the event of negative domestic shocks is 0.272DS + 0.253FS + (-0.145 + 0.093DS + 0.124FS) where DS and FS are domestic and foreign stock ratios respectively. The coefficients on both stock variables (in their interaction with negative domestic shock) are positivesuggesting that stocks – domestic and foreign – help in moderating the decline in rice consumption. However, the interaction of negative domestic shock with foreign stock is not significant. So is the foreign stock coefficient by itself.

On the other hand, the domestic stock variable is significant in itself and in its interaction with negative domestic shock. The combined effect is 0.365DS. The median value of domestic stocks as a proportion of consumption is 0.05. This means that its contribution in reducing the hit on consumption is about 1.8 percentage points. The 75-percentile level of stocks is 0.2, and at this level, stocks would arrest the decline in consumption by 7.3 percentage points.Domestic stocks would have to be 40% of consumption to wipe out the 14.5% decline in rice consumption (relative to base category) that is due to negative domestic shocks. Thus, while domestic stabilization policies through grain reserves have moderated consumption declines, their contribution at the median level of stocks is limited.

VII. CONCLUDING REMARKS

There is considerable literature about world price volatility and the transmission of world prices to domestic prices. In this paper, we have taken a different route to assess stability and to examine the role of trade and domestic stabilization policies. For each country, we constructed exogenous domestic and foreign (i.e., rest of the world) yield shocks, and looked at their impact on rice imports and on rice consumption. We also considered how this impact was modified by domestic and foreign stocks.

If supply shocks are uncorrelated across countries, the global supply is essentially stable. Provided that there are no demand shocks, the global price is also stable. Importing countries would be able to import, whenever they need to, at a stable price. Even if shocks are correlated across countries, as long as the correlation coefficient is less than 1, the global aggregate supply is a lot more stable than individual country supplies.

Although trade cannot be expected to play a strong role when the major producing and consuming countries are simultaneously hit by negative yield shocks, such a scenario obtains in only 3% of cases. In all other cases of negative domestic shocks, they could be at least partially neutralized by positive foreign shocks. This implies that in a world of free trade, consumption levels in individual countries would be stabilized. However, our study finds that this is not the case. In cases of adverse domestic shocks, consumption fails to be stabilized even when foreign shocks are positive; however, imports do peak. Thus, while trade does help in coping with domestic risks, it is unable to achieve full risk sharing. The flip side is that when domestic yield shocks are positive, consumption surges even when the shock in the rest of the world is negative.[9] Therefore, it is clear that irrespective of foreign shocks, the principal concern for poor countries is to stabilize consumption when hit by negative domestic yield shocks. The frequency of such shocks is about 12%.

[9]As a referee points out, this could be a statistical artifact, because changes in private stocks are not measured and therefore included in measured consumption.

Domestic policies have played a greater role in stabilizing the adverse impacts of negative shocks. This could be because of the presumed "unreliability" of rice trade. Storage is expensive, however, and countries often followingadhoc rules of thumb tend to carry too much stock either because of extreme precaution or because these policies are captured by producer interests.[10] A judicious combination of stocks and trade can be an effective tool to stabilizedomesticprices but at the cost of higher global price volatility (Gouel and Jean 2015). Otherwise, reliance on domestic stabilization will continue to keep rice markets thin and promote market insulation policies similar to those that led to the rice price spike in 2007–2008.

Cooperative solutions such as commonfood reserves could also serve as the region's insurance in times of food crises. Towards this end, ASEAN has been progressing to adopta framework to set aside and share rice stocks in contingencies. ASEAN includes some of the world's largest importers (Indonesia and the Philippines) and exporters (Thailand and Vietnam), and Myanmar, which isaspiring to regain its status ofthe 1950s as the world's largest exporter of rice.While regional stocks may be a good initiative to address crisis in individual countries, it is inadequate to deal with crises of regional proportions. To succeed, the region must establish a mechanism to mobilize collective action and cooperation especially when a shock affects multiple countries together(Jha and Rhee 2012).

The positive development in the world rice market has been the greater volume of trade since the mid-1990s due to the export liberalization in India and the entry of Viet Nam into world markets. Can there be another shift upwards? Surpluses in the commercial rice exporting countries such as Thailand, Pakistan, and the US are already high. Exports are as high as domestic consumption in Thailand and Pakistan, while in the US, the ratio is close to 60%. That is why the thickening of the rice market had to depend on new exporters such as India and Viet Nam.

Between 2006 and 2008, Viet Nam's exports were consistently around 21% of consumption. However, Indian exports have varied between 2.5% and 6% of domestic consumption. Not only has India's contribution to world exports varied, but the surpluses have also been small relative to domestic consumption. Negative domestic shocks together with domestic policies can shrink these surpluses quickly. Similarly, in the other large rice-producing economies such as Bangladesh, the PRC, and Indonesia, the surpluses or deficits are small relative to consumption, and it is not clear whether they can be reliable contributors to global supplies in the future. Besides, climate change poses unknown perils to some of the major rice growing regions in Bangladesh and India.

In this sense, the rise of Viet Nam is reassuring to the long-term future of the world rice market, although the surpluses are not as large as in Thailand. While surpluses may continue to rise in Viet Nam, especially with rising prosperity, we might need to see the emergence of surpluses in other countries for the rice market to thicken. Myanmar and Cambodia are possible candidates for rice export. As the PRC turns a net importer, low-income Greater Mekong Region in Southeast Asia holds significant potential to increase productivity and contribute to dramatic regional trade expansion (Jha et al 2010). But this can only be realized if policies are integrated and complementary.

High and volatile global prices generate panic herd behavior. Experience shows that anti-trade bias in agricultural policies such as price-insulating export restrictions and aggressive importations contribute significantly to world price rise. Food price volatility was higher when trade was

[10] Gilbert (2011), Knudsen and Nash (1990). For a review of Indian experience, see Ramaswami and Murugkar (2013).

impeded, e.g., during the two world wars, the breakdown of Bretton Woodsin 1970s and the global food price crisis in 2007. Restoring confidence in food tradeis the key butbinding countriesto agree multilaterally to limittrade restrictions– though plausible – does not seem feasible at present. Regional or bilateral agreements among Asian economies – which produce and consume over 90% of rice –could perhaps be the starting point. However, even within ASEAN progress in cooperation remains limiteddespite great potential for raising productivity, production and food security.

While it may seem that a more reliable rice-trading system would have to await greater productivity increases in some of the key rice-producing regions of the world, developing countries are also seeing a major paradigm shift in social safety net policies. The emphasis has shifted from commodity subsidies and market interventions to cash transfers. The shift in these policies is made possible by continuing developments in information and communication technologies. It is plausible that these trends may lead developing countries to de-emphasize grain stocks which in turn could lead rice trade to grow. However, as grain prices matter to the value of cash transfers, they will continue to be a high priority on the economic and political agenda of developing country governments.

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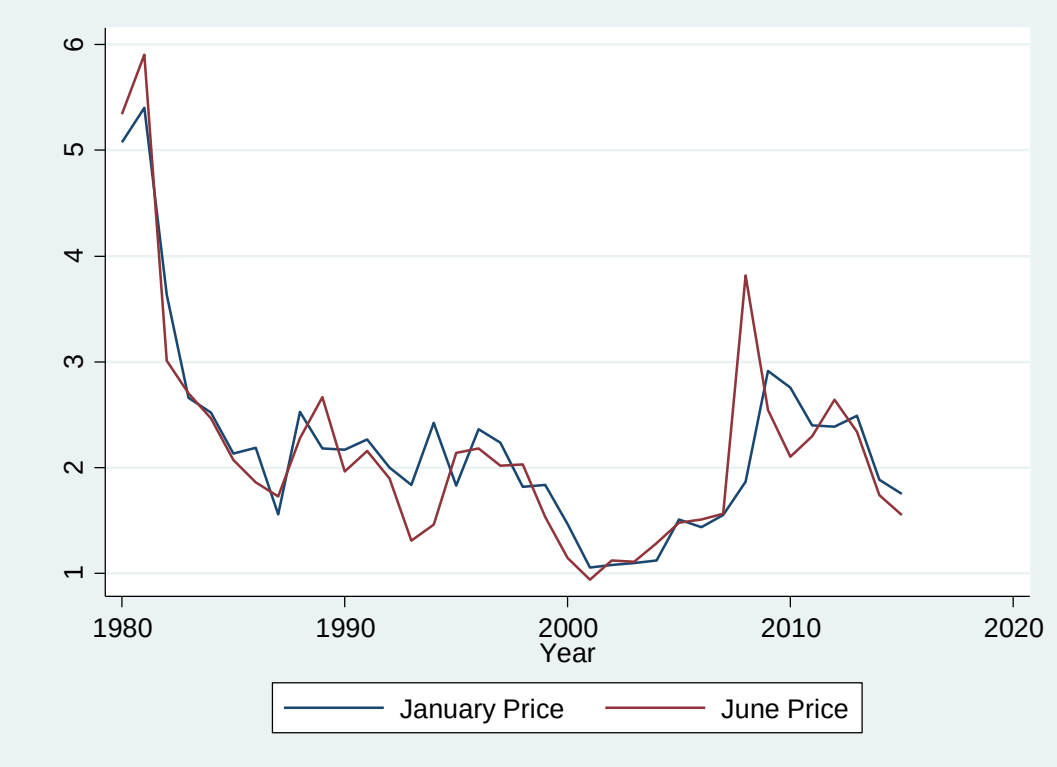
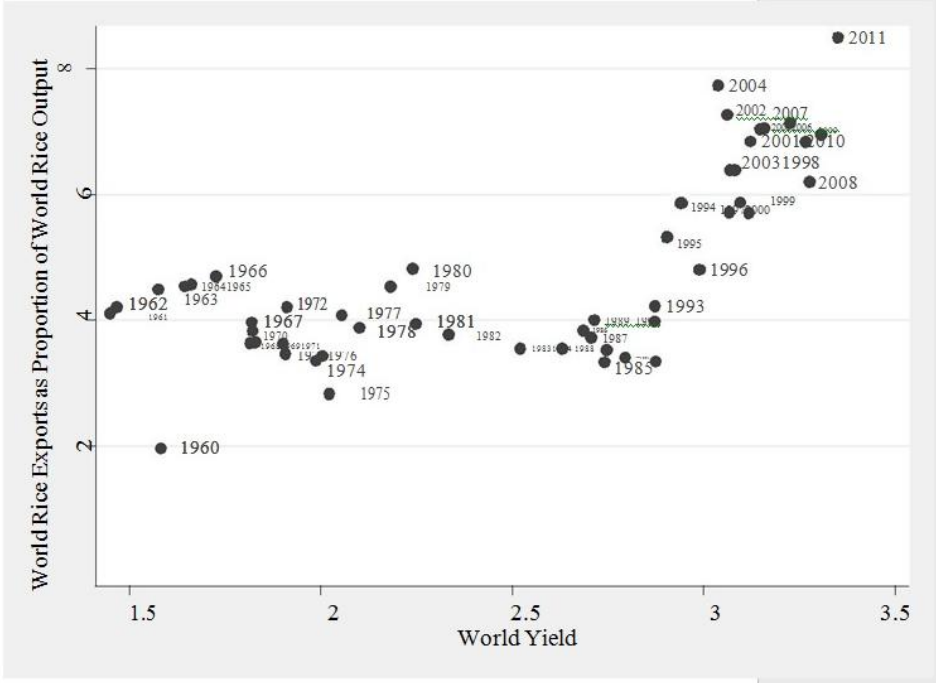
Figure 1: World rice prices, 1980-2015



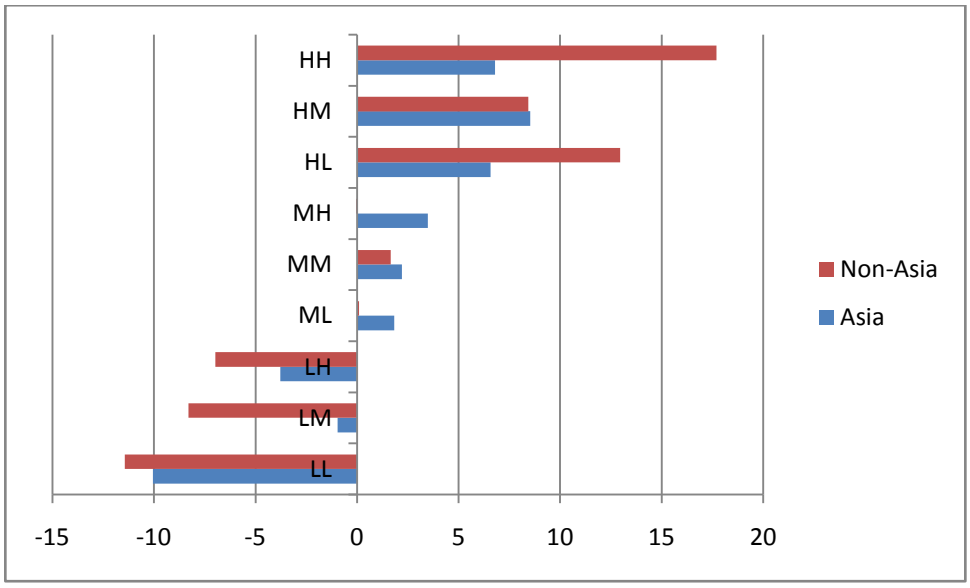
Note: World monthly rice prices (in US $ per ton) are sourced from IMF (http://www.imf.org/external/np/res/commod/index.aspx). The monthly prices are deflated by the US consumer price index sourced from the US government Bureau of Labor Statistics. The January prices refers to the prices prevailing in January while the June price refers to the prices prevailing in June.

Figure 2: World Rice Trade and World Yields



Source: Authors' estimates.

Figure 3: Percentage Changes in Rice Consumption: Asia Vs Non-Asia



Notes: Each scenario is denoted as XY, where the domestic shock X = {H, M, L} and the foreign shock Y = {H, M, L} and H, M and L represent the positive, medium range and negative shocks respectively.

Table 1: The World Export-to-Output Ratio

	1960–1993	1994–2011
Mean	3.82	7.16
Standard deviation	0.56	2.14
Coefficient of variation (%)	14.66	29.89

Source: Authors' estimates.

Table 2: Cross-Tabulation of Foreign and Domestic Yield Shocks, All Countries

	Foreign Yield Shocks			
Domestic Shocks	Negative High	Mid-range	Positive High	Total
Negative High	116	311	88	515
	2.72	7.31	2.07	12.10
Mid-range	533	2,111	550	3,194
	12.52	49.59	12.92	75.03
Positive High	9	363	91	548
	2.21	8.53	2.14	12.87
Total	743	2,785	729	4,257
	17.45	65.42	17.12	100.00

Note: Values in the lower row represent the number of cross-tabulated observations as a proportion of all observations.
Source: Authors' estimates.

Table 3: Cross-Tabulation of Foreign and Domestic Yield Shocks, Major Countries

	Foreign Yield Shocks			
Domestic Shocks	Negative High	Mid-range	Positive High	Total
Negative High	10	56	19	85
	1.48	8.30	2.81	12.59
Mid-range	91	334	76	501
	13.48	49.48	11.26	74.22
Positive High	22	49	18	89
	3.26	7.26	2.67	13.19
Total	123	439	113	675
	18.22	65.04	16.74	100.00

Notes:
1. Major countries are the major importing and exporting countries: Bangladesh, the People's Republic of China, India, Indonesia, Iran, Malaysia, Nigeria, Pakistan, the Philippines, Saudi Arabia, Thailand, the United States, and Viet Nam.
2. Values in the lower row represent the number of cross-tabulated observations as a proportion of all observations. Source: Authors' estimates.

Table 4: Imports Regression
Dependent Variable: First Difference of Log (Imports/Consumption)

Variables	Coefficients	Standard Errors	t-value
Dummy variable for negative domestic yield shock and negative foreign yield shock	0.398	0.131000	3.03
Dummy variable for negative domestic yield shock and mid-range foreign yield shock	0.286	0.113000	2.52
Dummy variable for negative domestic yield shock and positive foreign yield shock	0.636	0.141000	4.51
Dummy variable for mid-range domestic yield shock and negative foreign yield shock	0.139	0.108000	1.29
Dummy variable for mid-range domestic yield shock and mid-range foreign yield shock mm	0.182	0.102000	1.78
Dummy variable for mid-range domestic yield shock and positive foreign yield shock	0.112	0.109000	1.03
Dummy variable for positive domestic yield shock and negative foreign yield shock	–0.316	0.139000	–2.28
Dummy variable for positive domestic yield shock and mid-range foreign yield shock	0.057	0.112000	0.51
Dummy variable for positive domestic yield shock and positive foreign yield shock	(omitted)		
Constant	–0.181	0.100219	–1.80

Notes:
1. The number of observations is 2,683.
2. The sample of importing countries is for 1960–2010.
3. Regression model includes country fixed effects.
Source: Authors' estimates.

Table 5: Consumption Regression, All Countries
Dependent Variable: Log of change in rice consumption

Variables	Coefficients	Standard Errors	t-value	Coefficients	Standard Errors	t-value
Dummy variable for negative domestic yield shock and negative foreign yield shock	–0.222	0.032	–6.94	–0.219	0.042	–5.26
Dummy variable for negative domestic yield shock and mid-range foreign yield shock	–0.186	0.027	–6.80	–0.195	0.045	–4.37
Dummy variable for negative domestic yield shock and positive foreign yield shock	–0.176	0.034	–5.10	–0.188	0.054	–3.49
Dummy variable for mid-range domestic yield shock and negative foreign yield shock	–0.107	0.026	–4.10	–0.103	0.038	–2.71
Dummy variable for mid-range domestic yield shock and mid-range foreign yield shock mm	–0.092	0.025	–3.74	–0.088	0.041	–2.18
Dummy variable for mid-range domestic yield shock and positive foreign yield shock	–0.107	0.026	–4.11	–0.103	0.044	–2.35
Dummy variable for positive domestic yield shock and negative foreign yield shock	–0.006	0.034	–0.19	–0.027	0.046	–0.59
Dummy variable for positive domestic yield shock and mid-range foreign yield shock	–0.025	0.027	–0.92	–0.024	0.045	–0.53
Dummy variable for positive domestic yield shock and positive foreign yield shock	(omitted)			(omitted)		
Lagged dependent variable (1st order)				–0.344	0.033	–10.30
Lagged dependent variable (2nd order)				–0.117	0.033	–3.55
Constant	0.131	0.024	5.44	0.141	0.039	3.60

Notes:
1. The number of observations is 4,155 (3,885 for specification with lagged dependent variables).
2. The sample consists of 87 countries for 1960–2010, country fixed effects.
3. The specification with lagged dependent variables has been estimated with the Arellano–Bond method using second- to sixth-order lags of the dependent variable as instrumental variables.
Source: Authors' estimates.

Table 6: Consumption Regression, Selected Asian Countries
Dependent Variable: Log of change in rice consumption

Variables	Coefficients	Standard Errors	t-value	Coefficients	Standard Errors	t-value
Dummy variable for negative domestic yield shock and negative foreign yield shock	–0.169	0.034	–4.92	–0.185	0.010	–18.64
Dummy variable for negative domestic yield shock and mid-range foreign yield shock	–0.078	0.022	–3.52	–0.088	0.040	–2.21
Dummy variable for negative domestic yield shock and positive foreign yield shock	–0.106	0.025	–4.16	–0.119	0.041	–2.89
Dummy variable for mid-range domestic yield shock and negative foreign yield shock	–0.050	0.021	–2.34	–0.057	0.030	–1.93
Dummy variable for mid-range domestic yield shock and mid-range foreign yield shock mm	–0.046	0.020	–2.27	–0.052	0.027	–1.91
Dummy variable for mid-range domestic yield shock and positive foreign yield shock	–0.033	0.022	–1.54	–0.041	0.024	–1.70
Dummy variable for positive domestic yield shock and negative foreign yield shock	–0.002	0.025	–0.09	–0.016	0.020	–0.81
Dummy variable for positive domestic yield shock and mid-range foreign yield shock	0.017	0.022	0.77	0.000	0.027	0.00
Dummy variable for positive domestic yield shock and positive foreign yield shock	(omitted)			(omitted)		
Lagged dependent variable (1st order)				–0.235	0.102	–2.31
Lagged dependent variable (2nd order)				–0.144	0.085	–1.70
Constant	0.068	0.020	3.43	0.087	0.028	3.13

Notes:
1. The number of observations is 306 (288 for specification with lagged dependent variables).
2. The sample consists of six countries for 1960–2010: Bangladesh, the People's Republic of China, India, Indonesia, the Philippines, and Viet Nam; The regression uses country fixed effects.
3. The specification with lagged dependent variables has been estimated with the Arellano–Bond method using second- to sixth-order lags of the dependent variable as instrumental variables.

Source: Authors' estimates.

Table 8: Consumption Regression with Yield Shocks and Stocks
Dependent Variable: Log of change in rice consumption

Variables	Coefficients	Standard Errors	t-value
Lagged Dependent Variable (1st order)	–0.341	0.033	–10.39
Lagged Dependent Variable (2nd order)	–0.127	0.030	–4.25
Domestic stock/Consumption	0.293	0.096	3.05
Foreign stock/Foreign consumption	0.243	0.247	0.98
Domestic yield shock	0.195	0.079	2.46
Foreign yield shock	0.234	0.671	0.35
Domestic shock ×(domestic stock/domestic consumption)	–0.095	0.040	–2.39
Domestic shock ×(foreign stock /foreign consumption)	0.115	0.298	0.39
Foreign shock ×(domestic stock/domestic consumption)	–0.697	0.363	–1.92
Foreign shock ×(foreign stock /foreign consumption)	–0.052	2.832	–0.02
Constant	–0.058	0.060	–0.98

Notes:
1. The number of observations is 3,885 (87 countries); fixed effects at country level.
2. The model has been estimated with the Arellano–Bond method using second- to sixth-order lags of the dependent variable as instrumental variables.

Source: Authors' estimates.

Table 9: Consumption Regression with Yield Shocks and Stocks
Dependent Variable: Log of change in rice consumption

Variables	Coefficients	Standard Errors	t-value
Lagged Dependent Variable (1st order)	–0.338	0.032	–10.53
Lagged Dependent Variable (2nd order)	–0.119	0.030	–3.99
Domestic stock/Consumption	0.272	0.087	3.12
Foreign stock/Foreign consumption	0.253	0.289	0.88
Negative domestic shock	–0.145	0.039	–3.75
Negative domestic shock ×(domestic stock/consumption)	0.093	0.043	2.14
Negative domestic shock ×(foreign stock/foreign consumption)	0.124	0.127	0.97
Positive domestic shock	0.050	0.047	1.04
Positive domestic shock ×(domestic stock/consumption)	–0.096	0.046	–2.10
Positive domestic shock ×(foreign stock/consumption)	0.150	0.172	0.88
Negative foreign shock	–0.009	0.035	–0.26
Negative foreign shock ×(domestic stock/consumption)	0.071	0.059	1.21
Negative foreign shock ×(foreign stock/foreign consumption)	–0.050	0.140	–0.36
Positive foreign shock	0.044	0.031	1.40
Positive foreign shock ×(domestic stock/consumption)	–0.010	0.033	–0.29
Positive foreign shock ×(foreign stock/foreign consumption)	–0.236	0.136	–1.73
Constant	–0.054	0.070	–0.76

Notes:
1. The number of observations is 3,885 (87 countries); fixed effects at country level.
2. The model has been estimated with the Arellano–Bond method using second- to eighth-order lags of the dependent variable as instrumental variables.

Source: Authors' estimates.