What are grain reserves worth? A generalized political economy framework

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What explains volatility in world food prices? Are the "fundamentals" of supply and demand the basic factors? Can national or international policies toward food grain reserves help to stabilize food prices? What are food stocks "worth" if the levels of grain reserves, especially in large countries, affect food trade policies in these countries? This effect would be the reverse of the usual causation where policies can directly affect the levels of both public and private stocks.

There are four basic ways the profession thinks about these questions.

(1) The first is second nature to economists, who use basic supply and demand models as the fundamental explanation of price formation. The "fundamentals" approach uses these models to generate an equilibrium price, where the global level of stocks is an *exogenous* factor that influences the probability of a price spike when there are shocks to supply or demand. A number of well-calibrated models using this structure are used routinely, especially by such international research centers as FAO, FAPRI and IFPRI, to understand the impact of changing trends in supply and demand, and shocks, to food prices.

(2) The second approach explicitly introduces the storability of the commodity into price formation. The supply of storage model brings in expectations and makes stock levels endogenous with price formation. To be empirically useful, however, reasonably accurate and timely data on levels of stocks held by the commercial trade are critical. These models have a long history, but the standard reference remains Williams and Wright (1991). A modern application with important implications for the role of bio-fuels in food price formation is Roberts and Schlenker (2013).

(3) The third approach recognizes that such stock data are often not available for commodities where individuals and small firms hold a major share of stocks between harvest and consumption, a factor that is especially important for the world rice market (Timmer, 2009b). To cope with this reality of the industrial organization of some commodity markets, a behavioral model adds hoarding by individuals, with levels of stocks in the hands of these agents largely unobserved but important for short-run price formation. In this approach, "non-traditional speculation" in financial and commodities markets can also impact price formation without having a visible impact on *measured* stock levels (Timmer, 2012).

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(4) The fourth approach is quite new. A political economy model adds the behavior of policy makers (and other market participants) to explain changes in trade restrictions for grain (especially rice). "Confidence in trade" is a critical driver of political behavior and from there to volatility. Domestically held stocks contribute directly to confidence in trade, in a positive manner. In this model, levels of grain stock held domestically are an important factor in explaining price volatility, above and beyond their impact via the supply of storage model.

This paper reviews each of these approaches in turn. The goal of the paper is to provide new insights into how to answer the question: “What are grain reserves ‘worth’ in a world where trade restrictions drive food price volatility?”

A simple model of price formation with exogenous stocks

Consider the most basic model of commodity price formation that is capable of illuminating our problem (Timmer, 2009b).

$$D_t = f(a_t, P_t, sr_d, P_{t-n}, lr_d) = a_t P_t^{sr_d} P_{t-n}^{lr_d}$$

$$S_t = g(b_t, P_t, sr_s, P_{t-n}, lr_s) = b_t P_t^{sr_s} P_{t-n}^{lr_s}$$

where D_t = demand for the commodity during time *t*; S_t = supply of the commodity during time *t*; *f* and *g* = functional forms for demand and supply functions, respectively; a_t = time-dependent shifters of the demand curve; b_t= time-dependent shifters of the supply curve; P_t = equilibrium market price during time *t*; P_{t-n} = market price during some previous time period *t-n*; and, sr_d, sr_s, lr_d and lr_s = indicators that demand and supply responses will vary depending on whether they are in the short run *sr* or long run *lr*. In the specification below, these will be short-run and long-run supply and demand elasticities.

In short run equilibrium, $D_t = S_t$. For simplicity (and the ability to work directly with supply and demand elasticities), assume the demand and supply functions are Cobb-Douglas. Then

$$\log a_t + sr_d \log P_t + lr_d \log P_{t-n} = \log b_t + sr_s \log P_t + lr_s \log P_{t-n}$$

Solving for the equilibrium price *P*,

$$\log P_t = [\log b_t - \log a_t]/[sr_d - sr_s] + \log P_{t-n}[lr_s - lr_d]/[sr_d - sr_s]$$

Taking first differences to see the factors that explain a change in price from *t-1* to *t* reveals a somewhat complicated result:

$$d\log P_t = \{[\log b_t - \log b_{t-1}] - [\log a_t - \log a_{t-1}]\}/[sr_d - sr_s] +$$

$[\log P_{t-n} - \log P_{t-(n+1)}][lr_s - lr_d]/[sr_d - sr_s]$,

where $d\log P_t$ = the percentage change in price from time period *t-1* to time period *t* (for relatively small changes). This is what we are trying to explain. What "causes" changes in $d\log P_t$? Why are food prices high or low?

To answer these questions, it helps to simplify the equation. Let *SR* = the net short-run supply and demand response $sr_d - sr_s$, which is always negative because $sr_d < 0$ and $sr_s > 0$. Let *LR* = the net long-run supply and demand response $lr_s - lr_d$, which is always positive, for similar reasons (note that the demand coefficient is subtracted from the supply coefficient in this case, the opposite from the short-run coefficients above). Let $d\log b_t = \log b_t - \log b_{t-1}$, which for small changes is the percentage change in the supply shifters. Let $d\log a_t = \log a_t - \log a_{t-1}$, which for small changes is the percentage change in the demand shifters. Finally, let $d\log P_{t-n} = \log P_{t-n} - \log P_{t-(n+1)}$, which for small changes is the percentage change in the commodity price for some specified number of time periods in the past, for example, five or ten years (after which the long-run producer and consumer responses to price have been realized).

Combining all of these new definitions, we have a simpler equation explaining percentage changes in commodity prices:

Percent change in P_t *= [percent change in* b_t *- percent change in* a_t*]/SR*

+ [percent change in P_{t-n}*] LR/SR*

The "surprising" result is how simple the answer appears to be. There are four key drivers:

the relative size of changes in a_t to b_t--i.e., factors shifting the demand curve relative to factors shifting the supply curve;

the relative size of short-run supply and demand elasticities (sr_s and sr_d);

the relative size of long-run supply and demand elasticities (lr_s and lr_d); and

how large the price change was in earlier time periods.

A simple numerical example, with plausible parameters, shows the power of this "explanatory" equation. Assume the following numerical parameters for purposes of illustration:

sr_d = -0.10

sr_s = +0.05

lr_d = -0.30

$lr_s = +0.50$

These values imply that *SR* = -0.15 and *LR* =0.80.

The short-run elasticities assumed here are quite low, but realistic for annual responses.[2] Demand responds 1% for a 10% change in price; supply only responds by half a percent to a similar 10% price change (the signs, of course, are negative for demand and positive for supply responses).

The long-run elasticities are also on the low side of econometric estimates, but again, seem realistic for a world facing increasing resource constraints. Although some estimates of long-run supply response are quite high—approaching unity or higher--these were estimated for time periods when acreage expansion was significant and fertilizer usage was just becoming widespread (Peterson 1979).

Assume, as seems to be the case since the early 2000s, that demand drivers have been larger than supply drivers, with demand shifting out by 3.0% per year and supply shifting out just 1.5% per year. Finally, assume that prices in the past have been "low." The change in P_{t-n} is -10.0%. What do all these parameters mean for current price change?

Plugging these values into the price change equation yields the following result:

$$\text{Percent change in } P_t = [1.5\% - 3.0\%]/-0.15 + [-10.0\%]0.80/-0.15$$

$$= [10.0\%] + [53.3\%]$$

$$= 63.3\% \text{ higher.}$$

This is a very dramatic result. The imbalance between "current" supply and demand drivers causes the price to rise by 10%, but the historically low prices (and "only" a 10% decline in the earlier period) cause current prices to be 53% higher, as the long-term, lagged response from producers and consumers to these earlier low prices has a very large quantitative impact. *Much of the slow run-up in food prices from 2003 to 2007 would seem to be caused by producers and consumers gradually responding (i.e., reflecting their "long-run" responses) to earlier episodes of low prices, especially from the late 1990s until about 2003.* For example, between 1996 and 2001, the real price of rice declined by 14.7% per year in world markets!

Over long periods of time, the first driver is obviously the most important—how fast is the demand curve shifting relative to the supply curve? At the level of generality specified in this model, the actual underlying causes of these shifts do not matter. All that matters is the net result. If the demand curve is shifting outward by 3% per year, and the supply curve is shifting out by just 1.5% per year, the difference of 1.5% per year will push prices higher, by an amount

[2] They are also consistent with the estimates by Roberts and Schlenker (2013), although they attribute more of the price response to supply and less to demand.

determined by net short-run supply and demand elasticities with respect to price. The "simple" fact is that changes in commodity prices are driven by the net of *aggregate* trends in supply and demand, not their composition.

The analytical model of price formation makes a sharp and important distinction between factors that shift the demand and supply curves (the a_t and b_t coefficients) and the responsiveness of farmers and consumers to changes in the market price (the sr_s and sr_d coefficients), which show up as movements along the supply and demand curve. Analytically, the distinction is very clear, but, empirically, it is often hard to tell the difference. If farmers use more fertilizer in response to higher prices for grain, should this count as part of the supply response or as a supply shifter? If governments and donor agencies restrict their funding of agricultural research because of low prices for grain, is the resulting lower productivity potential a smaller supply shifter a decade later or a long-run response to prices? Whatever the labels, it is important to understand the causes.

In a world modeled by the fundamentals of supply and demand, price volatility is driven by exogenous shocks to either—bad weather on the supply side, for example, or a bio-fuel mandate to convert corn to ethanol on the demand side. The price response to such shocks then depends on the structural parameters of the model—the short-run and long-run price elasticities of supply and demand—and on the potential for stocks to mitigate shortfalls or surpluses. The size of these stocks, and thus their potential to mitigate price volatility, is exogenous to the model. The next section discusses the potential to bring decisions about stock levels into the supply and demand framework via the supply of storage model.

The supply of storage model and short-run price behavior

Almost by definition, the role of stocks in commodity price formation is restricted to short-run influences. In the long run, food demand cannot exceed the amount of food supplied. Still, much of the concern about volatile food prices reflects short-run issues. Price spikes, for example, tend to last only a year or two. Food prices can be depressed for decades at a time—from 1985 to 2005, for example, but they are not volatile during these periods because stocks tend to accumulate during periods of low prices. Large stocks and low prices are, of course, linked.

The link between the supply of grain held in storage and prices in both spot and futures markets has long been the subject of analytical attention (Working 1949; Weymar 1968; Williams and Wright 1991). The basic "supply of storage" model that has emerged from this theoretical and empirical work is the foundation for understanding short-run price behavior for storable commodities (Houthakker 1987). It stresses the inter-related behavior of speculators and hedgers as they judge inventory levels in relation to use. *The formation of price expectations is the key to this behavior.*

The basic supply of storage model is a simple extension of the supply/demand model already used here. The formulation here follows Weymar's presentation, with three behavioral equations and one identity (error terms are omitted for simplicity):

$$C_t = f_c(P_t, P_t^L) \tag{1}$$

$$H_t = f_h(P_t, P_t^L) \tag{2}$$

$$(P_t^* - P_t) = f_p(I_t) \tag{3}$$

$$I_t = I_{t-1} + H_t - C_t, \tag{4}$$

Where C = consumption, P = price, P^L= lagged price, H = production (harvest), I = inventory, and P^*= expected price at some point in the future.

> The first two equations, indicating the dependency of consumption and production on current and/or lagged price, reflect traditional micro economic theory. While other variables may appear in these relationships (e.g. consumer income, government support levels), their exclusion here will not affect the discussion that follows. [The third equation] represents the "supply of storage" curve … and reflects the notion that the amount of a commodity that people are willing to carry in inventory depends on their expectations as to future price behavior. If they feel that the price will increase substantially, they will be willing to carry heavier inventories (supply more storage) than would otherwise be the case. Because the inventory level is in fact determined by the identity expressed in [the fourth equation], the

> supply of storage function can be used to explain the gap between the current price and price expectations in terms of the current inventory level. [Weymar 1968: 28]

Thus the relationship between current inventories and current price helps explain price expectations, and vice versa. These price expectations can then be expressed in prices on futures markets. The actual working out of this theory empirically requires a close understanding of the behavior of market participants—farmers, traders, processors, and end users (consumers)—in their role as hedgers or speculators. The current controversy over the role of "outside" speculators—investors who are not active participants in the commodity system—has many precursors in the history and analysis of commodity price formation on futures markets.

The empirical difficulty in using the supply of storage model to understand short-run price behavior is having current information on inventory levels. This is not such a severe problem when virtually all the commodity storage is in commercial hands, as with cocoa or wheat, and stock levels for such commodities can be estimated fairly accurately. For a commodity such as rice, however, which is mostly grown by smallholders, is marketed by a dense network of small traders and processors, and is purchased by consumers in a readily storable form (milled rice), stock levels can change at any or all levels of the supply chain, and there are virtually no data available on these inventory levels. To make matters worse, a number of countries (especially China) regard the size of publicly held stocks of grain as a state secret. It is thought that China holds as much rice in storage as the rest of the world combined.

For the purposes here, then, the main advantage of the supply of storage model is its ability to build conceptual links between long-run supply and demand trends, where basic models of producers and consumers provide operational guidelines to decision-making and price formation, and very short-run movements in prices that often seem totally divorced from supply and demand fundamentals. Because long-run trends are gradually built up from short-run observations, these links are essential for understanding price behavior even in the long run.

The key, then, to making the supply of storage model operational in the short run is to use it to gain insight on formation of price expectations. In the very short run, from day to day or week to week, these expectations seem to be driven by a combination of price behavior for commodities broadly and the specifics of individual commodities. Broad commodity price trends are captured by the IMF commodity price index, the *Economist* price index, or the Goldman-Sachs commodity price index, for example. Thus, traders operating in any one specific commodity market, such as oil, corn or wheat, will be following closely the broader price movements for all commodities (Irwin, Sanders and Merrin 2009). These broad price movements seem to be driven by basic macroeconomic forces such as rates of economic growth, the value of international currencies, especially the U.S. dollar, and relative rates of inflation.

But traders are also following closely the specifics of the commodity as well. Here inventories (especially relative to actual use for consumption) are the key to price formation, once the harvest/supply situation for the crop is established. At this point, the analytics of price behavior for oil or metals begin to look quite different from the analytics of food commodities at this stage, as seasonal production and the inherent need to store the commodity for daily use throughout the year drive inventory behavior via the supply of storage.

Typically, commodities for which inventory data are reasonably reliable tend to have their prices driven by unexpected supply behavior. Commodities with poor data on inventories, especially where significant inventories can be in the hands of millions of small agents—farmers, traders, consumers—tend to have their extremes in price behavior generated by rapidly changing price expectations themselves, and consequent hoarding or dis-hoarding. The short-run price dynamics for rice thus look significantly different from those for wheat or corn, partly because of the different industrial organization of the respective commodity systems. Gilbert (2012) and Tadesse, et al., (2013) reach the same conclusion.

Behavioral dimensions of food security: Herd behavior and hoarding

Experience with world rice prices since the middle of the decade illustrates the importance of behavioral factors in short-run price dynamics. The actual production/consumption balance for rice has been relatively favorable since 2005, with rice stocks-to-use ratios improving slightly. This stock build-up was a rationale response to the very low stocks seen at the middle of the decade and to gradually rising rice prices—exactly what the supply of storage model predicts. Short-run substitutions in both production and consumption between rice and other food commodities are limited, and until late 2007 it seemed that the rice market might “dodge the bullet” of price spikes seen in the wheat, corn and vegetable oil markets. The lack of a deeply traded futures market for rice also made financial speculation less attractive.

But the world rice market is very thin, trading just 6-7 percent of global production.[3] While this is a significant improvement over the 4-5 percent traded in the 1960s and 1970s, it still leaves the global market subject to large price moves from relatively small quantity moves.

The global rice market is also relatively concentrated, with Thailand, Vietnam, India, the US and Pakistan routinely providing nearly 4/5 of available supplies. Only in the US is rice not a “political commodity” from a consumer’s perspective (although it certainly is a political commodity for producers in the US). All Asian countries show understandable concern over access of their citizens to daily rice supplies. Both importing and exporting countries watch the world market carefully for signals about changing scarcity, while simultaneously trying to keep their domestic rice economy stable.

[3] The standard early introduction to the distinctiveness of the world rice market is Wickizer and Bennett, 2014. The most recent review of the world rice economy, especially the crisis in 2007/08, is in Dawe, 2010.

As concerns grew in 2007 that world food supplies were limited and prices for wheat, corn and vegetable oils were rising, several Asian countries reconsidered the wisdom of maintaining low domestic stocks for rice.[4] The Philippines, in particular, tried to build up their stocks to protect against shortages going forward. Of course, if every country – or individual consumer – acts the same way, the hoarding causes a panic and extreme shortage in markets, leading to rapidly rising prices. Even US consumers are not immune from this panic, as the "run" on bags of rice at Costco and Sam's Club in April, 2008, indicated. Such price panics have been fairly common over the past 50 years, but the hope was that deeper markets, more open trading regimes, and wealthier consumers able to adjust more flexibly to price changes had made markets more stable. It turns out this was wishful thinking.

After an acceleration started in September, 2007 in the gradual price increases seen for half a decade, concern over the impact of higher rice prices in exporting countries, especially India, Vietnam and Thailand, started to translate into talk, and then action, on export controls.[5] Importing countries, especially the Philippines, started to scramble for supplies. Fears of shortages spread and a cumulative price spiral started that fed on the fear itself.

The trigger for the panic was provided by inter-commodity price linkages. In India, the 2007 wheat harvest was damaged by drought and disease – as in so many other parts of the world. Thus the national food authority had less wheat for public distribution. Importing as much wheat as in 2006 (nearly 7 mmt) would be too expensive (both economically and politically) because of the high wheat price in world markets, so the food authority announced it needed to retain more rice from domestic production.

Barriers were put on rice exports in September– India is often the second largest rice exporter in the world, 5 mmt in 2007 – and eventually an outright ban on exports of non-Basmati rice from India was announced in February, 2008. Other rice exporting countries followed, as rice prices started to spike.

The newly elected populist government in Thailand did not want consumer prices for rice to go up, and the commerce minister openly discussed export restrictions from Thailand – the world's largest rice exporter, 9.5 mmt in 2007. On March 28, 2008, rice prices in Thailand jumped $75 per mt. Prices continued to skyrocket until it cost over $1100 per mt in April. This is the stuff of panics.

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[4] What follows is a very brief overview of the "fire" in the world rice market from late 2007 until mid- 2008. See Slayton (2009) for a detailed analysis and chronology.

[5] It is almost amusing that Indonesia announced a ban on rice exports early in 2008, before its main rice harvest started in March. Historically, Indonesia has been the world's largest rice *importer,* surpassed only recently by the Philippines, and no one in the world rice trade was looking to Indonesia for export supplies. But there was a rationale to the announcement by the Minister of Trade—it signaled that Indonesia would not be needing imports and was thus not vulnerable to the skyrocketing prices in world markets. The calming effect on domestic rice market participants meant that little of the hoarding behavior seen in Vietnam and the Philippines was evidenced in Indonesia.

Low and declining rice stocks have been held accountable for the rising prices, with the argument that rice consumption has outpaced rice production for a number of years since 2000 (a mathematical inevitability if rice stocks are falling). Rice stocks in China have come down over the past decade, but that was a sensible response to growing reliance on trade as the buffer, and to lower prices in world markets. There has been little change in rice stocks in the rest of the world—indeed, the stocks-to-use ratio has been rising since 2005. Holding rice stocks in tropical conditions is extraordinarily expensive, so a smoother flow of rice internationally reduces this wasteful stockholding (Dorosh and Rashid, 2013; Gouel, 2012).

Now that the exporting countries are clearly willing to put bans on rice exports to protect their own consumers, nearly all countries will be forced to resort to domestic stockpiles. That is a real tragedy for poor consumers and for economic growth—capital tied up in funding inventories is not very productive in stimulating productivity growth.

The psychology of hoarding behavior is important in explaining why rice prices suddenly shot up starting in late 2007. Financial speculation seems to have played only a small role (partly because futures markets for rice are very thinly traded). Instead, decisions by millions of households, farmers, traders and some governments sparked a sudden surge in demand for rice and changed the gradual increase in rice prices from 2002 to 2007 into an explosion.

A rough calculation of the effect of household hoarding of rice shows the potential. Assume that one billion households consume one kg of rice a day (for a total consumption of 365 million metric tons (mmt), for the year, which is the right magnitude).

Assume they keep a one-week supply in their pantry, or 7 kg per household, which is 7 mmt of household stocks in total. This quantity probably varies by income class, with the very poor buying hand to mouth, and better off households storing more just for convenience. When prices start to rise, or the newspapers/TV start talking about shortages of rice, each household, *acting independently*, decides to double its own storage, thus buying an additional 7 kg per household. This means the world rice market needs to supply an additional 7 mmt of rice over a short period (a few weeks...). This quantity is about one quarter of total annual international trade in rice (recent levels have been 27-30 mmt per year).

Roughly 7 mmt is just the added demand from households. Farmers, traders, rice millers and even governments will also want to hold more stocks in these circumstances. As an example, the government of Malaysia announced that it was doubling the size of the national buffer stock held by BERNAS, even though it had to pay extremely high prices to do so. The Philippines increased its government-held stocks. Indonesia tripled its level of buffer stocks, from 1.0 mmt to 3.0 mmt.

To determine the impact on prices, short-run supply and demand parameters from the analytical model developed above can be inserted into the price determination mechanism: -0.1 for demand and 0.05 for supply. With a 25 percent increase in short-run demand on the world market (suddenly), the world price will have to rise by 167 percent to get a new equilibrium. That is what happened—*panicked hoarding caused the rice price spike*.

Fortunately, a speculative run can be ended by "pricking the bubble" and deflating expectations. Once the price starts to drop, the psychology reverses on hoarding behavior by households, farmers, traders, and even governments. When the government of Japan announced in May, after considerable international urging, that it would sell 300,000 tons of its surplus "WTO" rice stocks to the Philippines, prices in world rice markets started to fall immediately (Slayton and Timmer, 2008). By late August, medium quality rice for export from Vietnam was available for half what it sold for in late April, as dis-hoarding gained momentum.

The introduction of "outside" stocks into the world rice market was what pricked the price bubble and ended the hoarding behavior. What were these stocks "worth?" They were very expensive for the Japanese government to store, and it was the effort by the Japanese Ministry of Finance to recoup their total investment cost during price negotiations with the Philippines that led to their ultimate failure. Alternative rice supplies were quickly available at a lower cost once the panic had subsided. From that perspective, the Japanese stocks were invaluable. They brought stability to the world rice market.

Grain reserves and the behavior of policy makers

Restricting the flow of commodities across international borders almost inevitably increases the volatility of prices for those commodities in the residual world market (Anderson, 2012). Although WTO agreements have helped maintain relatively open markets on the import side, they have not been effective in preventing exporters from using trade restrictions to stabilize food prices domestically. The political economy of export restrictions seems pretty obvious. Most leaders understand they have a mandate to provide reasonably stable food prices to their citizens, and retaining more domestically-produced food at home when prices are spiking in world markets is easy, visible and politically popular.

History demonstrates that rice prices within many Asian countries *can* be kept reasonably stable with respect to world prices (Dawe and Timmer, 2012). The problem is that there are often spillovers from the actions undertaken by countries to stabilize their domestic prices, and these spillovers increase price instability in world markets (Martin and Anderson, 2012). A little-researched topic is how to *minimize* the impact of these spillovers, or *cope* with them on a country-by-country basis, rather than to follow the standard policy advice, which is to *avoid* the actions altogether, and thus avoid the spillovers in the first place. *The standard policy advice turns out to be politically impossible in times of turbulent markets.* Is there a better alternative, i.e. is there a way to keep borders more open to trade in basic food commodities, in both directions?

There are several components to the answer. First, we need a serious new research program on the benefits and costs of stabilizing food prices *within domestic economies*, including a focus on implementation of policy, management of food logistics agencies, and instruments to control corruption in these agencies[6]. We would know a lot more about these topics if we had spent the same resources answering these questions as we have spent over the past three decades in estimating the gains from free trade in agriculture.

Second, we need to understand how to build political confidence in trade as a step toward more open trade policies. Recent confidence-building measures have helped renew trust in the world rice market, which has been more stable since 2009 than world wheat and maize markets—a very significant reversal of historical patterns of food price volatility. Severe damage to this trust was inflicted during the 2007-08 food crisis, mostly because of the Indian ban on exports, the on-again, off-again ban on Vietnamese rice exports, and open talk in Thailand of withholding stocks from the market and creating an "OREC," or Organization of Rice Exporting Countries, to boost prices in the world market (Dawe and Timmer, 2012; Dorosh and Rashid, 2013). Still, there is plenty of blame to go around in explaining the political distrust of the world market for rice. Important importing countries, such as Indonesia and the Philippines, speak publically of their desire to end "dependence" on supplies from the world market. Such rhetoric does not make them a market that exporting countries can trust.

This retreat into autarky comes at a very high price to economic efficiency and the welfare of poor consumers. It makes the world market even more unstable and less reliable. But by understanding the behavioral foundations of food security and its political economy, it is possible to re-build confidence and trust in international trade in general and in the world rice market in particular. These confidence-building measures will need to involve both exporting and importing countries, *acting in their own self-interest*. One possibility—already underway--is a country-by-country investment in greater rice reserves to cope with *shocks* to rice supplies, while gradually increasing the use of trade to *lower costs* of rice consumption. A higher level of stocks does not alter the requisite flow of rice from producers to consumers, but it does create a buffer against interruptions to that flow. Thus, larger stocks contribute directly to greater confidence in using the world rice market to lower the costs of food security in importing and exporting countries alike.

Third, we need an "Asian Rice Forum" to meet regularly as a venue, especially for the largest countries, to discuss their policy approaches to the sector (and to express quietly any concerns about the behavior of their trading partners). This might be an initiative for the ASEAN + 6 group of countries, which includes all of the major rice players in Asia. A top agenda item for the first meeting of such a forum would be an *explicit* discussion, at the level of heads of state, of

[6] A start on this research is in Bellemare, Barrett, and Just, 2013, and Gouel, 2013.

how to maintain and build greater trust in the world rice market. Trust can be both personal and institutional, and both are needed in this instance.

Because of the sheer size of their *domestic* rice economies, actions to increase production, reduce consumption, or alter the size of stocks held by public agencies in the largest Asian countries will also have a noticeable impact on the *international* rice economy. These countries certainly include China and India, probably Indonesia, and possibly the Philippines and Bangladesh.[7] Larger rice reserves in these countries are probably desirable for reasons of domestic food security, but they will also alter the perception of global observers about the adequacy of worldwide stocks. Fortunately, this process is already well underway. That is, *larger rice reserves in these countries—built up since 2008—have had a positive spillover impact on the global rice economy by stabilizing price expectations*, and thereby actual rice prices. The stability in global rice prices since 2008, relative to wheat and maize prices, is largely attributable to more attention in the large Asian countries to their own domestic food security, including holding larger rice stocks.

[7] India, Thailand and Vietnam, as the world's leading rice exporters, carry substantial stocks both seasonally and as part of their normal pipeline for regular deliveries to their customers. They are unlikely to need larger stocks for food security reasons.

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