

Grain Reserves and Food Security in MENA Countries

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Abstract

Aggregate stocks of major grains declined to minimal feasible levels in 2007/08, due to high global income growth and biofuels mandates. Given minimal stocks, prices were very sensitive to shocks such as the Australian drought and biofuels demand boosts due to the oil price spike. The effects of these shocks were magnified by a sequence of trade restrictions by key exporters to protect vulnerable consumers, beginning in the thin global rice market in the fall of 2007, which turned market anxiety into panic. Recognizing the unreliability of imports, vulnerable countries, including those in the Middle East and North Africa, (MENA), are now considering investing in strategic reserves, pursuit of self sufficiency, and acquisition of foreign land to ensure supplies for grain for domestic consumption. The associated expense and negative incentive effects of national reserves may be acceptable if they have quantitative targets related to the consumption needs of the most vulnerable, with distribution to the latter only in severe emergencies. In many MENA countries, heavy subsidies on grain consumption of both rich and poor reduce the stabilizing response of consumption to price, and increase the size of reserves needed to ensure any given level of food security. In most MENA countries, accumulation of stocks is a more efficient strategy than pursuit of self sufficiency, because these countries have no comparative advantage in expanded agriculture, due fundamentally to lack of water supplies. Acquisition of foreign lands leaves food supplies exposed to sovereign risk and other interruptions to the supply chain beyond the importer's control. On the other hand collaboration among MENA countries could allow them to smooth a sizeable part of the risks posed by fluctuations in their own harvests.

1. Introduction: The food price crisis of 2007/08 and the emergence of concerns over its impact on food security

After experiencing the turmoil in the grain markets starting in 2007, the prospect of continuing high grain market volatility is particularly threatening to countries of the Middle East and North Africa (MENA).¹ Their special vulnerability comes from their high levels of cereal consumption and heavy dependence on imports (World Bank, 2009). As much as 35 percent of calorie consumption in the region comes from wheat alone, and the region is collectively a net importer of 58.1 million metric tons of cereal, making it the largest net importing region in the world. Import dependence is projected to increase from 56 percent in 2000 to 63 percent in 2030, leaving the region even more vulnerable to high and volatile international market prices.

In the throes of the market chaos of 2007/08, pressure from their urban consumers forced many importers, including some MENA countries like Morocco and Saudi Arabia to remove tariffs or subsidize imports of grains (Hater, 2008). These importer policies stabilized local markets to some extent, but they penalized the domestic farmers and traders whose supplies to the market prevented more serious shortages. Furthermore, their collective effect was to exacerbate international price volatility. On the other side of the market, exporters responded to similar pressure from their politically powerful consumers by limiting or banning exports, which penalized their producers and further destabilized the international market on which importers relied for food security. (See Wright forthcoming.)

As grain prices have receded significantly from their 2008 highs, the policy focus switched from short-term tactics for crisis management to strategies to manage the effects of market fluctuations on consumers at acceptable cost. Suggestions to increase global grain reserves have figured prominently in international discussions. Proposals have been made for international reserves combined with what advocates describe as “virtual reserves” controlled via commodity futures and options trading. Special regional emergency reserves have been proposed for

¹ Countries generally included in MENA are Algeria, Bahrain, Djibouti, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Ethiopia, Sudan, Syria, Tunisia, United Arab Emirates, and Yemen. The total population is similar in size to that of the European Union.

countries that view possible lack of access to the global trade as a serious issue. Some observers have also recommended regulation of commodity futures trading by noncommercial investors, while Ethiopia is supporting establishment of a new futures exchange as part of their grain market policy (Jopson and Blas, 2008). Many have pressed for reductions in subsidies or mandates for biofuel production, on the grounds that such policies threaten the stability of food markets. Several MENA countries, along with China and India, have taken steps to secure land in Africa and elsewhere to produce grains to augment their domestic supplies (Economist 2009).

After price volatility subsided, Russia, a recently emerged major exporter, formulated a proposal for a wheat export cartel with the other large Black Sea exporters, Ukraine and Kazakhstan, and this idea was discussed at the World Grain Forum in St. Petersburg in 2009. It was clear that problems with market access and exposure to exporter supply manipulation might persist for some time. Only a year later, in the summer of 2010, Russia announced a grain export ban in response to unprecedented hot weather and fires in its wheat producing regions, and there are rumors of bans by the Ukraine and others. Wheat prices have recently jumped, and food security is now on the policy agenda as both a pressing short run issue and a longer run policy challenge for nations in the MENA region.

In this context, the main objective of this paper is to provide government officials, civil society organizations and officials of international organization involved in food security with an overview of the potential roles and problems associated with using physical storage and related policies as means of enhancing food security. The paper discusses how MENA countries can use storage to address their food security related needs and challenges. It shows how storage, if properly managed, can effectively integrate international trade and other domestic policies in achieving an acceptable level of food security. In particular, it concludes that storage will inevitably be used to reduce the risks of food shortages. In doing so, it will be important to avoid the unsustainable costs associated with complete self-sufficiency in food production by countries with a limited agricultural production potential due to water scarcity and other resource related constraints.

We aim to put in proper perspective the many options that are currently being discussed in various forums in the MENA region by policy makers who rightly consider food security for their citizens to be an important national goal. The paper is designed to assist those countries

who aim to achieve greater food security by illuminating the costs as well as the benefits of alternative routes that might be taken in pursuit of that goal.

2. Strategy and policy options for enhanced food security in the Arab region, in face of recent food price volatility

2.1. Aggregate food price behavior in the past two decades.

Figure 1 shows the United Nations FAO food price index, a measure of behavior of aggregate food prices in the past few decades. Essentially flat in the early 1990s, it rose substantially around 1996, then declined to a new lower base 1998 until 2003. The index then began to rise, and by 2005 had risen almost 20% above the 1998–2000 average. In 2006 price increases started to accelerate, and by October were on a sharp uptrend that continued until summer 2008, when the index exceeded twice its 2005 level, but since then has fluctuated considerably. It is now above its average level in 2007, though still substantially below the 2008 peak.

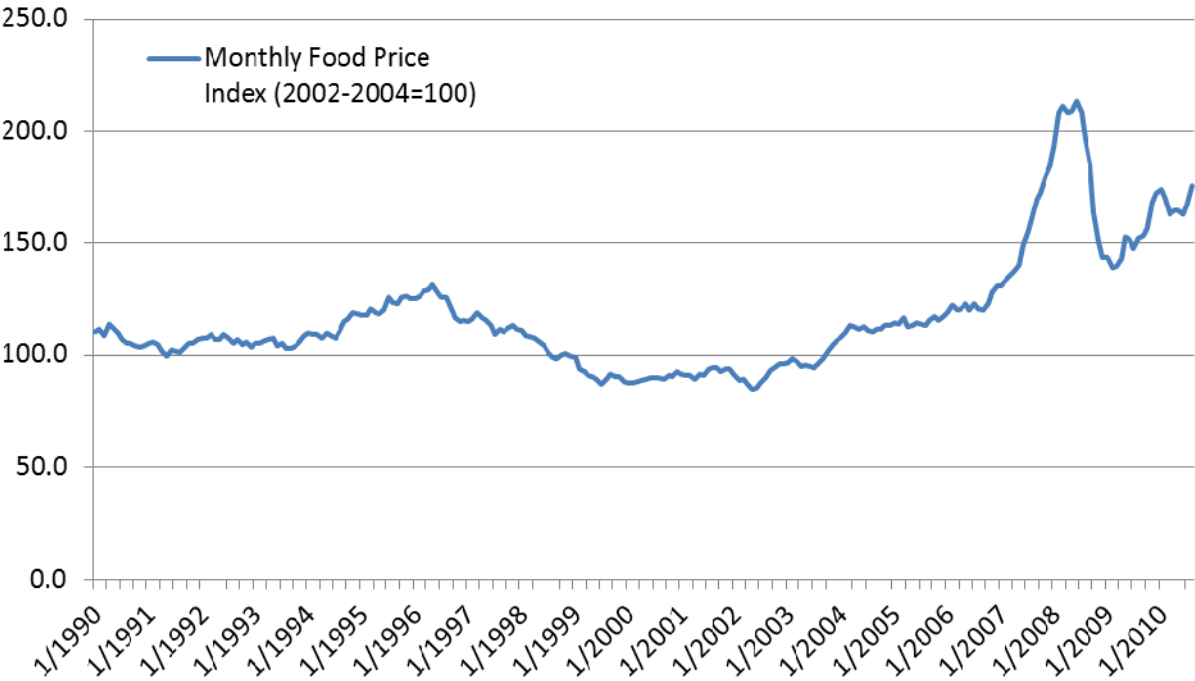


Figure 1
UN FAO food price index (1990–2009) (2002/04=100)
(Source: FAO)

This aggregate food price index understates the fluctuations in the prices of the major food grains that have attracted the bulk of the attention in discussions of food prices. Figure 2, which offers a longer view, shows that the real price of wheat in the US followed a downward trend for decades, reflecting the fact that yield growth has on average exceeded demand growth, contrary to Malthusian predictions of the 1960's. The price generally moves within a narrow band along the downward trend. At irregular intervals, large price jumps occur, generally succeeded immediately by steep falls back towards the trend level. Price troughs well below trend are not evident; price behavior is asymmetric.

Figure 2 shows that, relative to other periods of price turmoil, recent experience is not atypical. In fact, relative to the early 1970s, the price movements appear rather modest. Here we focus on wheat due to its particular importance in the MENA diet, but similar features are seen in the behavior of the other major grains, maize and rice. (See Wright forthcoming for details.)

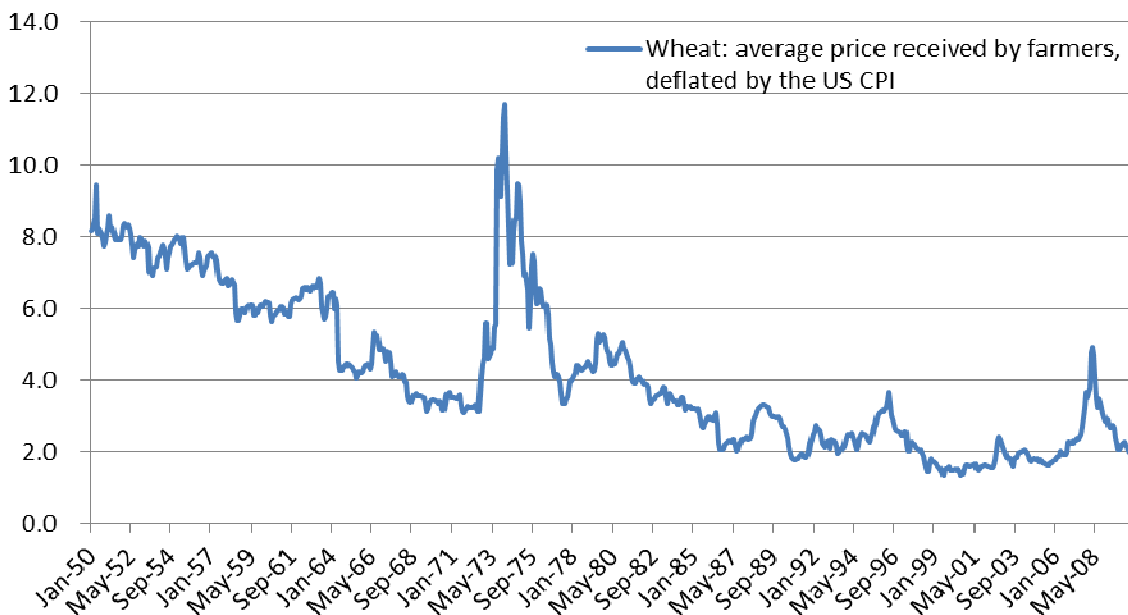


Figure 2
Real price of wheat in the US (1950–2009)
 Dollars per bushel deflated by U.S. CPI (1982–1984=1)

The overall downward trend in the price of wheat, and of the other major grains, reflects the fact that persistent achievements in crop breeding, and reductions in prices of complementary inputs, kept grain supplies increasing faster than aggregate grain demand for human food and animal

feed. The trend increase in demand for human consumption of grain has recently been driven mainly by the increase in the global population, and the rate of increase has been slowing down in recent decades. Only in poorer countries is increase in income an important driver of grain consumption per capita, which is naturally limited by the capacity of the human stomach. For grains used for animal feed, the trend increase in consumption has been greater, because human consumption of animal products continues to rise with income long after minimum calorie requirements have been satisfied. Use of maize as an animal feed has boosted its demand beyond what would be expected from its use as a staple food in many countries. Animal feed accounts for a smaller but still significant share of wheat production, notably in Europe. Rice is used predominantly as a food.

There is substantial agreement about the drivers of these longer run trends in grain consumption and prices. By contrast, there is a wide diversity of opinion regarding the causes of recent grain price volatility.

2.2. What caused recent grain price gyrations?

Among most economists, there is an emerging consensus about the contributions of different factors to the recent volatility in the markets for major grains. Predictable disturbances can cause price trends, but cannot cause price spikes unless normal market responses are somehow constrained.² Price spikes are generated by surprises. Thus, the recent rapid increases in income in China and India induced an increase in global demand for food and feed grains, but these increases, sustained for several years, were only a surprise to the extent that their continuation into 2008 was unexpected. Similarly, reductions in the rate of yield increases in rice and wheat could have contributed to a tighter market, but as medium-term phenomena related to global neglect of research on increased crop yields; they can hardly have been surprises. Excellent discussions of these factors are available elsewhere.³

² For example, the large increase in crude oil price in 2008 was predicted by the huge contango in the futures market, but lack of storage capacity precluded the intertemporal arbitrage that would normally smooth the price response.

³ See Abbott et al. (2008, 2009), Mitchell (2008), Timmer (2008), and Gilbert (2008).

Factors such as the unprecedented extension of the Australian drought, other regional production problems, possible effects of global warming, and exchange rate movements, were much less predictable. However, as noted elsewhere, their influence has not been large enough to explain most of the price spikes seen in 2007/08.

Three other market disturbances that could not have been well predicted before 2007 were global in influence, and deserve particular attention. They are the changes in biofuel demand and medium-term biofuel policies, and spikes in the prices of fertilizers and fuel. As all three relate directly to recent price spikes in the petroleum market, they merit special consideration by a regional group which includes many of the world's major petroleum exporters.

2.2.1. Biofuel demand

In the past decade, a huge new global demand has entered the market for grains, oilseeds, and palm oil. For the first time, a large part of grain calories is being allocated to uses other than food and feed. The rise of biofuels demand, largely unplanned, but largely determined by administrative mandates rather than market demand, has meant that food and feed users must share their supplies with energy users. The conversion of oilseeds into biodiesel in Europe, the United States, and elsewhere, of sugar into ethanol in Brazil, and of maize into ethanol in the United States, are phenomena that link events in the world energy markets to food market behavior in a qualitatively new way.⁴

In the United States in particular, the diversion of corn and soybeans to biofuels now approaches 30% for corn and 20% for soy, and will continue to increase under current policies using subsidies and mandates, as well as protection from competition from more efficient Brazilian sugar-based ethanol production. The southern corn leaf blight infestation of 1971, which cut the U.S. corn harvest by only half the percentage currently used for biofuels. Yet it was viewed as a very serious shock to the agricultural sector. It directed new attention to the security of the U.S. food supply, and induced policy makers to devote more resources to the conservation of plant varieties for agriculture and diversification of genetic resources available to plant breeders.

⁴ Though Brazil is a major biofuel producer (using sugar cane), its production apparently has not diverted large acreages from grain production. Recent sugar market volatility, however, has directed more attention on the food market implications of Brazilian reliance on sugar-based production of ethanol.

Furthermore, the mandates for diversion of United States maize for biofuel, unlike a drought, have signaled reductions in supply for food and for years to come, and have much more serious implications for supplies of maize for feed and food than an equivalent yield drop due to a transitory, weather-related infestation.

The mandates constitute a particularly serious threat to food security because, unlike feed demands, they are quantitative measures lacking the inherent price-sensitivity of demands from a competitive animal feeding industry. Indeed, they act like floors on demand; if oil prices rise high enough, biofuels can be profitable substitutes for petroleum even without the mandates; any excess capacity above mandated levels will be utilized to increase substitution for petroleum where feasible.

Biofuel producers and farmer now constitute powerful lobbies in favor of continued and indeed upward revision of mandates in the United States and Europe, and they vigorously support arguments that biofuels have negligible, or even negative, effects on global food prices. However few competent economists would argue that a sustained reduction of 30 in US corn production or 20% in soy production would not raise short and medium term food prices. In the short run, unanticipated demands for biofuels feedstocks no doubt reduced grain stocks in the last decade and were a crucial element in the subsequent price gyrations of 2007/08. In the medium run, global agriculture will not be able to make up the supply shortfall for food and feed users. (If it does, there is the possibility that biofuels mandates, supported by biofuels interests, will expand even further.) Biofuels are now acting like a huge global grain acreage control program, raising average prices, favoring farmers who are net grain sellers, at the expense of food consumers, with particularly serious effect on poor consumers exposed to global price changes.

For MENA nations, a major concern is the price of wheat, a staple food in the area. Wheat is not a large biofuel feedstock, but that does not mean that MENA nations are not exposed to food security implications of the new global regime. Recent experience has revealed that when maize was diverted to ethanol, and oilseeds diverted to biodiesel, wheat and other food grains were diverted to provide the animal feed that would have been supplied by the diverted corn and soybeans. Consumers also increased their demand for rice, to replace the wheat used for feed. Biofuel demands, and surges in meat demand caused by rising global incomes, also affected food grain markets less directly, and with a lag, by diverting inputs, in particular land and fertilizer,

from food grains to production of feed and biofuels. In India, land was diverted from sugar to grains, leading to a sugar supply crisis in that country. Biofuels have made food and feed calories more expensive and more vulnerable

2.2.2. Prices of fertilizers and fuels

Worldwide adoption of modern high-yield plant varieties and a decline in the opportunities for expansion of cultivated area have increased the demand for fertilizers. Prices of some fertilizers rose faster than any agricultural commodity price in 2007/08, reflecting short run supply constraints, energy costs and transport costs. Although some farmers and ethanol producers have blamed fertilizer and oil prices for grain price spikes, the evidence is not convincing. Grain prices rises associated with previous harvests preceded fertilizer price movements, rather than vice versa.

Crude oil, like fertilizer, is an important input—both directly and indirectly—into modern agriculture. Its price is virtually independent of disturbances in grain markets. Crude oil prices have been very high recently, but again there does not seem to be a large effect on acreage or yield even in the countries that use petroleum intensively in production. Farm land prices in the United States rose dramatically as grain, fuel, and fertilizer prices were all rising, indicating the net effect on farmers' profits and incentives was positive and large.

On the other hand, unpredictable changes in petroleum prices affected grain demand. As noted previously, jumps in petroleum prices now not only affect farmers' costs but also shift the demand for the grain they produce via increased biofuel demand. This is a new phenomenon. When ethanol production exceeds mandated levels, marginal fuel price changes increase total demand for grains even as they increase input costs.

Pursuing this line of argument, a reasonable expectation might be that income growth and biofuel demand should have had less influence on the volatility of rice prices relative to maize and wheat prices. Yet the fact that the price spike was the highest for rice in 2008 points to another significant contributor to chaos in the world grain markets: panic in the rice trade.

2.2.3. Panic-driven trade interventions

The recent turmoil in grain prices reflects random fluctuations in global weather, but also unpredictable shifts in policies. Important examples include shifts in biofuels policies in the past decade noted above. But equally important, for the security of MENA nations, are disruptions of global trade by measures to relieve pressure on politically active consumers when supplies are tightening, including export bans or export taxes, on the one hand, and reductions in tariffs or import levies on the other. Mitchell (2008) and Slayton (2009) discuss how the price surge started in October 2007 when India, confronting a low wheat harvest, announced a rice export ban to protect its consumers from inflation. Over the next half year other major exporters limited exports in response to the uncertainty in the global market, which in turn was exacerbated by the bans (Wright forthcoming).

The effects of this episode highlighted the strong substitution, at the margin, between the three major grains. Indeed, as argued elsewhere (Bobenrieth and Wright 2009) the market for the major grains can be usefully considered as a market for grain calories.⁵ For MENA countries, this means that their reliance on wheat does not insulate them from disturbances in the markets for other grains. They must recognize that shocks to the demand for maize for biofuels, for example, will have a relative impact on international wheat prices and availability comparable to the impacts on maize markets. Currently, the effects of the disruption of Russian wheat production by drought and fires have been magnified by the Russian announcement on August 5, 2010 of a ban on wheat exports, which caused wheat futures to jump up to the price move limit of 8.3%. There are rumors that the ban has spread to other countries around the Black Sea; another cascade of panic-driven market closings might now be beginning, despite the third largest wheat harvest on record. This type of exporter panic could be a real threat to the security of import-dependent consumer nations in the MENA region if global stocks of grain are low.

Other factors discussed as possibly disruptive to grain markets include the prices of fertilizers and fuels. A biofuel producer association recently made the claim that oil prices are the greatest threat to food security, and biofuels, by easing pressure on oil supplies, actually reduce food price inflation. However, input price rises would affect grain prices only with a lag. Further,

⁵ Roberts and Schlenker (2009) go further, and include soybeans as a fourth source of aggregate calories.

recent grain price increases have been accompanied by large land price jumps, making cost-driven theories implausible.

Reviews of the grain price volatility of the past few years have allocated percentage shares of responsibility to a set of factors. This approach would make sense if these factors had a linear cumulative effect on food price volatility. But the effect is in fact highly nonlinear. When supplies are already tight, a further small supply reduction, or new market order, if unexpected, can become the “straw that breaks the camel’s back,” and cause a sharp price spike. This nonlinearity merits attention, as it is a key to understanding recent market events and constructing appropriate policy responses.

The economics of storage arbitrage determines the highly nonlinear relationship between grain prices and available supply, and helps in the evaluation of claims that other factors are the key drivers of market volatility. To understand this nonlinearity of the relation between prices and supply, it is necessary to grasp some fundamental features of grain storage as an economic activity. The effort is worthwhile, considering that only analyses that make substantive use of the theoretical restrictions imposed on price movements by the intertemporal arbitrage obtained via stock management can correctly identify the welfare effect of seasonal price changes. These theoretical models allow separating the demand for consumption from the implicit demand for storage, under specific assumptions on the competitive structure of the storage industry. Once the intertemporal price smoothing potential ensured by storage management is understood, policy analysts may be better equipped to consider the value of alternative policy interventions that might increase the effectiveness of storage management in enhancing food security.

2.3. The economics of storage activity

The influence of storage on consumption and price of grains is illustrated in Figure . The annual harvest in year t , h_t , is random, reflecting the influences of weather and other disturbances on production. Total demand is the horizontal sum of two demands. One is the demand for consumption in the current period, c_t ; the other is the demand for grain stocks, x_t , to carry

forward for later consumption.⁶ Consumption responds to price according to the downward-sloped market demand function $P(c_t)$. Stocks x_t cannot be negative.

In storage arbitrage, regardless of the economic setting (monopoly, competition, state control of resource allocations) two accounting relations hold. Available supply, A_t , is the sum of the harvest, h_t , and stocks carried in from the previous year, x_{t-1} , and consumption is the difference between available supply and the stocks carried out. Profit-maximizing storers hold positive stocks only if they expect returns to cover costs. If storers are competitive, the current price of a

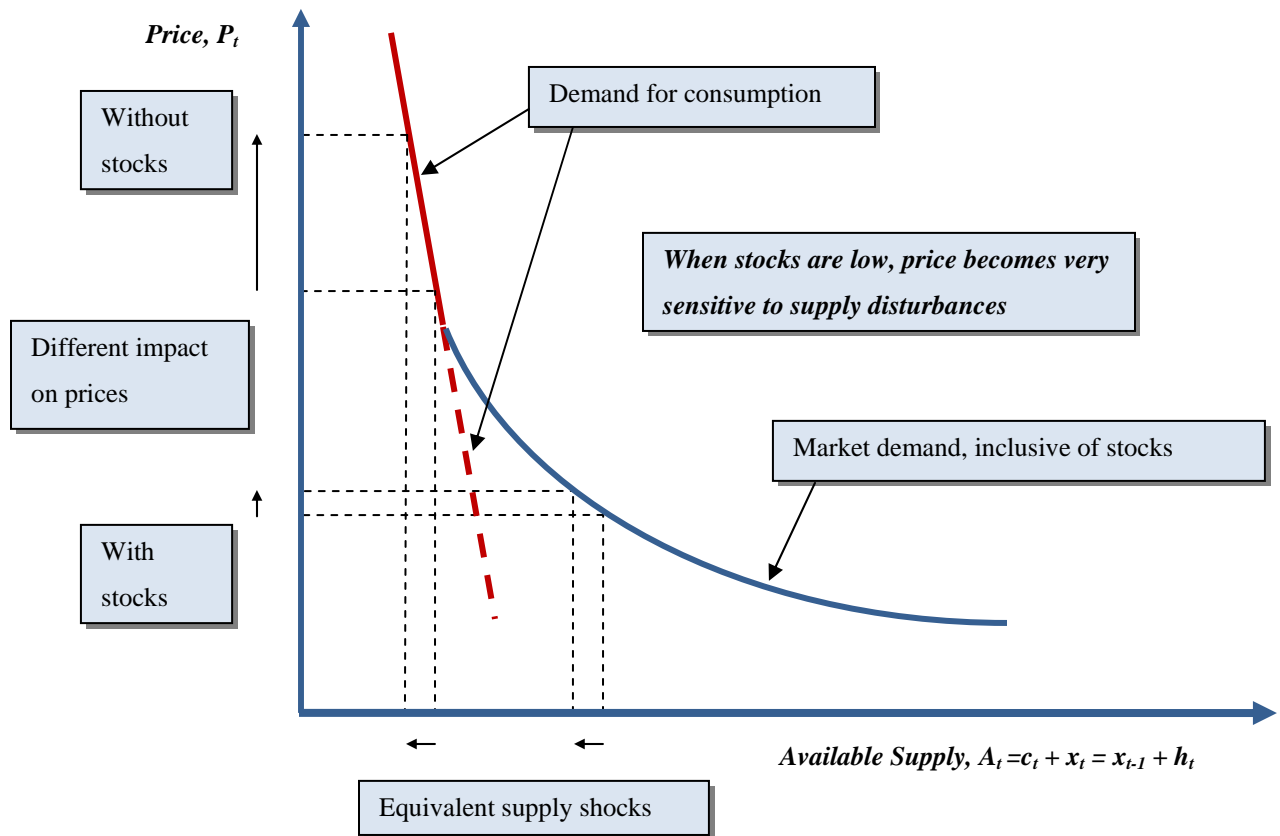


Figure 3
The role of stocks in buffering shocks

unit stored must be expected to rise at a rate that covers the cost of storage and the interest charge on the value of the unit stored.

⁶ We ignore essential working stocks, which by definition do not change as prices change, and we ignore deterioration of stocks.

Given available supply, A_t , storers carry stocks x_t from year t to year $t+1$ following a version of the age-old counsel to “buy low, sell high.” As shown in Figure , where the consumption demand is a downward sloping straight red line, if price is sufficiently high, carried over stocks are zero.

When price is high and no stocks remain, those who consume grains such as rice, wheat, or maize as their staple foods are willing to give up other expenditures (including health and education) to continue to eat their grain, so the consumption demand is very steep and unresponsive to price (“inelastic”); large changes in price result as consumption adjusts to the full impact of a given supply shock. In 1972/73, for example, a reduction in world wheat production of less than 2% at a time when stocks were almost negligible, caused the annual price to more than double (Figure 2). When stocks are high, a similar supply shock would have a far smaller effect on price.

In essence, by acquiring stocks when price is low, storers can reduce the rise in consumption and thus cushion the associated fall in price. Disposal of stocks when supplies become scarcer reduces the severity of price spikes. If the supply of speculative capital is sufficient, storage can eliminate negative price spikes *but can smooth positive spikes only as long as stocks are available*. When stocks run out, aggregate use must match a virtually fixed supply in the short run. Less grain goes to feed animals and the poorest consumers reduce their calorie consumption, incurring the costs of malnutrition, hunger, or even death.

If producers can respond to incentives with a one-year lag, that response is highly stabilizing for consumption and price. If, for example, an irrigation system that has been shut down to save scarce “fossil” water can be maintained in usable condition, it could furnish an emergency production reserve that could stabilize consumption in times of severe shortage, without the high capital cost of holding extra emergency stocks to ensure a similar level of security.

In such markets, measuring both consumption and stocks (including stocks held by consumers) is very difficult. (In recognition of this, grain statistics refer to “disappearance” rather than consumption.) This fact complicates food policy targeted at ensuring minimum consumption for all during shortages. Also, a common feature of all such physical storage activity is that, from a global viewpoint, aggregate stocks are constrained to be non-negative (even if there exist the conditions by which further release of stock would be profitable, if current stocks are zero, it is

impossible to “borrow from the future.”) This fact makes modeling storage behavior particularly challenging. It also makes estimation of market behavior based on available data very difficult.⁷

2.3.1. How global storage affects world grain markets

To interpret the behavior of grain market prices, and identify the causes of high volatility, it is crucial to understand how storage behavior as described above affects the relation between prices and available supplies of grain. A glance at Figure , which depicts the series of annual stocks-to-use ratios and of annual real price indexes for wheat, reveals that the wheat price spikes in the 1970s, in 1995/96, and in 2007/08 occurred when world stock-to-use ratios were low. For the market to function effectively, a virtually irreducible minimum amount of grain must be held in the system to transport, market, and process grains. (For example, no matter how urgent is the demand for grain to consume today, some must be held on docks as ships are loaded and unloaded, and in other elements of the supply chain.) Though stocks data are notoriously imprecise, minimum working stocks are apparently close to 20% of use.⁸ Comparison of the two series in Figure shows that stocks are very unresponsive to price at these minimum levels. A similar comparison for maize would reveal the same phenomenon: spikes in maize price occurred when stock-to-use ratios were low.

⁷ For estimation of storage and consumption behavior in markets for some major commodities see Cafiero, Bobenrieth, Bobenrieth, and Wright (2009).

⁸ Above minimum stocks, small additional fractions of stocks are placed on the market only when the incentive is high, because they are in relatively inaccessible locations or perform valuable roles in keeping the system operating efficiently. These stocks are ignored here; they play only a minor role in the determination of price volatility. See Bobenrieth, Bobenrieth and Wright (2004).

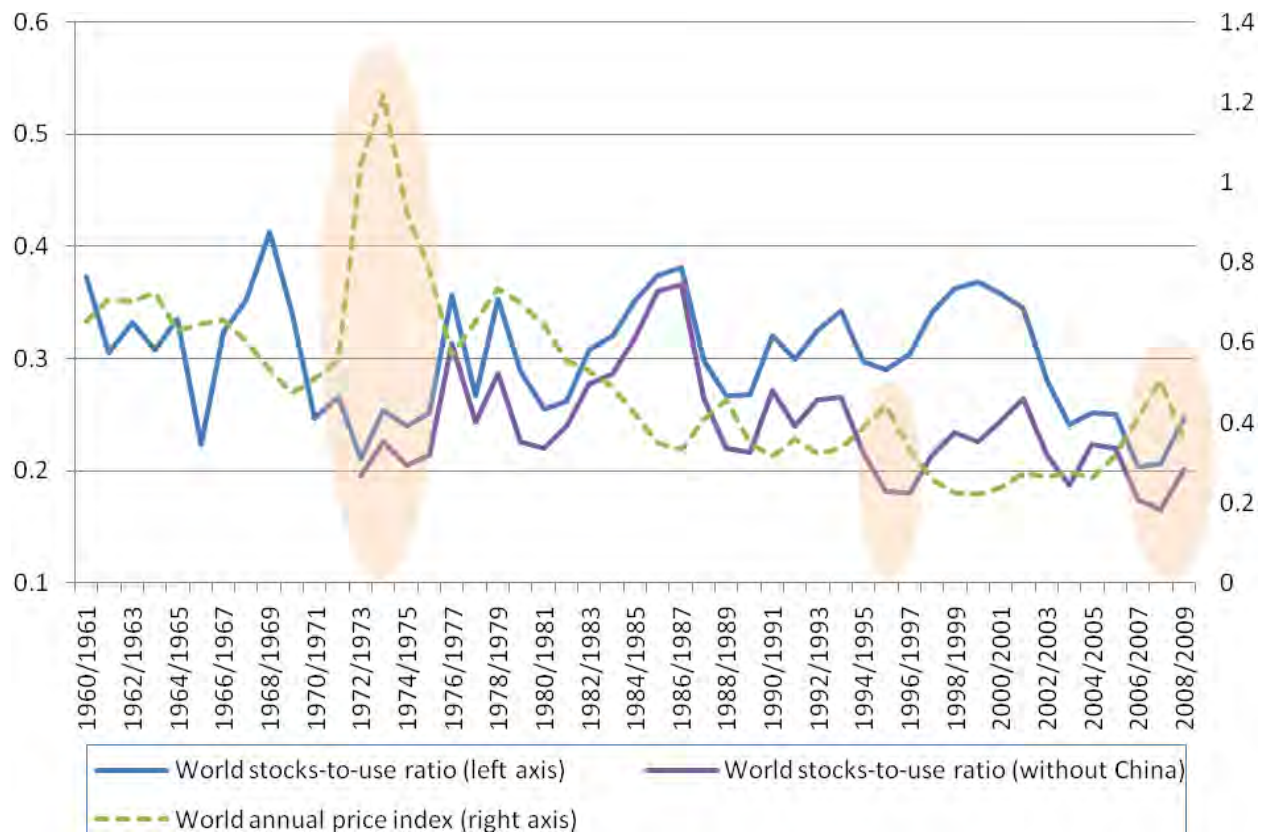


Figure 4
World wheat stocks-to-use ratio and World price index.

Source: USDA for stocks-to-use-ratio and World Bank for price index (calendar year average of monthly figures reported for US.No.2 Hard Red Winter, fob at US Gulf ports)

Another important feature of these grains (and of most minerals) is that the marginal cost of storage per period, including physical protection, insurance and spoilage, in practice is usually modest, and the assumption of constant unit costs is a generally reasonable approximation in regions where humidity is low and modern infrastructure is available.⁹ The main cost of storage of grains is usually the cost of the capital invested in accumulating the stocks. Increases in stocks of grain are not generally limited by storage capacity, in contrast to above-ground stocks of petroleum or water. A profit is realized from storage of grain only if the value of the grain when released exceeds the sum of the cost of storing it and the interest on capital.

⁹ Paul (1970). Deterioration is not important for grains stored in dry environments, but can be serious in hot and humid environments.

3. Why public policies are needed to achieve optimal grain supplies

In modern capitalist economies, an undistorted free market might be expected to equate the value of grain used for current consumption with the value of grain stored for the future, that is, of grain placed in storage. However there are two serious problems with total reliance on private storage for national food supplies. The first is that in a free market only those who have the necessary resources or “entitlements” can acquire food. The destitute may starve without affecting prices at all. The other is that in a food emergency (such as experienced in many countries in 2008) there is a universal tendency to identify scapegoats for high prices or scarce supplies. Governments are pressured by politically powerful consumers to force traders who have accumulated grain to surrender those stocks to the government or directly to consumers, often without compensation, and/or to limit the participation of “speculators” in grain markets. Sometimes such so-called “hoarders” are also punished or otherwise penalized. At such times, the argument that, if the next crop fails, such “hoarders” might be the sole source of supply, and speculators the key source of investible fund, gets scant attention.¹⁰

Anticipation of such treatment discourages private storage in times of plenty for distribution at a high price in time of need. Even if a government announces a commitment not to confiscate stocks (or otherwise penalize hoarders) in emergencies, such a commitment is not credible. Hence governments often choose to supplement private storage with publicly acquired stocks or storage subsidies. (Even if the government manages all market stocks, consumers inevitably store some domestic supplies.) When public stocks are released to consumers they will, to some extent, have a negative effect on prices.¹¹ Anticipation of this price effect reduces private storage incentives. Hence it is natural to expect that governments will intervene actively when supplies are plentiful to increase grain stocks with a view to ensuring supplies for the needy and/or stabilizing the market.¹² Such a government role is familiar to the peoples of the MENA

¹⁰ In the United States, long-run speculators, whose futures positions provide the incentive for storage by short-hedgers, are currently enduring a great deal of negative attention regardless of a lack of evidence of excessive stocks.

¹¹ Such a negative effect will not exist when food is distributed to those with no money at all. Contrary to generalized sales from the public stockpile, targeted food distribution programs will have minimal impact on market equilibria.

¹² For a more extensive discussion of the rationale for public intervention in storage markets, see Wright and

countries. Since ancient times, national leaders in the region have recognized that the state has a responsibility to ensure adequate domestic availability of staple foods, and have used public stocks of grain to fulfill this responsibility. We will turn now to the analysis of such policies.

3.1. Traditional price-stabilization policies

International agreements involving commodities, including rubber, cocoa, and tin, have often combined an acquisition price, at which the commodity is purchased from the market and placed in storage, with a higher “ceiling” or “release” price, at which stocks are made available for sale by the stabilization authority. This is called a “price band” scheme. If the ceiling or release price coincides with the acquisition price, the scheme is a simpler “price floor scheme, which keeps price at the floor until stocks are sold out, or until all cash for purchases has been expended. In the past, prominent economists have advocated that prices should be stabilized in a band bounded by the floor and ceiling prices to reduce the “boom and bust” gyrations typical of commodity prices (Keynes 1942, Houthakker, 1967, Newbery and Stiglitz 1981).

A strong intuition is that such a program keeps the price around the middle of the price band most of the time if the band is judiciously chosen. But numerical examples made possible by advances in computing and dynamic programming show that this is not true.¹³ As examples in Williams and Wright (1991) show, there is little probability that price will be located between the mid-point of the band and the top. Most of the time, the market appears to be “challenging” either the floor or the ceiling price. The enforcement of a price ceiling discourages production and private storage, and increases volatility of the price (relative to a market with only private storage) as the latter approaches the ceiling. However, sales from the public stockpile at the ceiling reduce the frequency of even higher prices quite markedly. Thus, the program poses a tradeoff involving a much higher probability of the price remaining at or near the ceiling, in exchange for less frequent episodes of food reaching even higher prices.¹⁴

Williams (1982) and Williams and Wright (1991, chapter 15).

¹³ Modeling the dynamic equilibria of storable commodity markets requires use of numerical techniques to solve for a function that links equilibrium price to available supply. Simulation of long series of random harvests is used to characterize the distribution of prices implied by the parameters of the model. For details, see Williams and Wright (1991).

¹⁴ For an example of projection of the impact of alternative storage schemes on the probability distribution of prices

A serious consideration for price band schemes is budget cost. There is an appealing intuition that if the mean of the floor and ceiling price equals the free-market mean, the program can be regarded as “self-liquidating”—that is, financially sustainable— based on the expectation that net balances should equal zero and on the intuition that the summed funds from purchases and sales after several years of operation should be close to their initial values. But this intuition is wide of the mark even for a simple floor price scheme in a market with linear demand and no underlying trend. As simulations demonstrate, over the years the balances of such programs have no tendency to cluster near zero, and indeed will eventually expend any initial capital limit, perhaps after accumulating large surpluses.

This result should be taken very seriously. Experience since the Second World War has affirmed that the time before these types of programs fail is typically disconcertingly short, often less than a decade or two. Recent failures in programs for tin and wool, among others, have shown that the largest and most catastrophic price effect of these interventions can be the severe price collapse that accompanies their inevitable failure.¹⁵

When such price stabilization programs do fail, there is usually a public consensus that the failure is due to poor administration, but the fundamental problem resides in the appealing but faulty intuition about how the program should work.

3.2 Recent proposals for global price stabilization

3.2.1 An international coordinated global food reserve

An international coordinated global food reserve has recently been proposed.¹⁶ This reserve is presented as a means of reassuring importers that they could rely on exporters to supply them in time of need. The proposal is sketched as an agreement by members of a “club” that would include members of the G8+5 plus major grain exporters such as Argentina, Thailand, and Vietnam, who would commit to holding specified amounts of public grain reserves in addition to reserves held by the private sector. The public stores would be used to intervene in the spot

for a model calibrated on data from Bangladesh, see Brennan (2003)

¹⁵ See Bardsley (1994), Gilbert (1996), and Haszler (1988).

¹⁶ von Braun et al. (March 2009).

market as directed by a “high level technical commission” appointed by the club on a permanent basis. The commission would have full decision-making authority.

This proposal has some features in common with the current security provisions of the International Energy Agency for dealing with disruptions of petroleum markets. A major, and perhaps insurmountable, challenge for such a commitment-reinforcing program is to ensure commitment by the participants themselves to honor their obligations and make their stocks available when markets are under stress. This is a serious issue, since the members of the club include some exporters whose lack of commitment to their customers was a key factor in the recent turmoil in the global grain trade.

3.1.1. A global virtual reserve

Another related proposal is for a global “virtual reserve.” Nations that are members of the “club” would commit funds amounting to US\$12–20B to be provided, if necessary, by the high-level technical commission for operations in the futures markets.¹⁷ One version of the proposed intervention characterizes it as a dynamic price-band system (von Braun et al., 2009, p. 3) operated by a “global intelligence unit” that also makes market forecasts and determines when markets are not functioning well. This unit would be part of an institution that “already has the long- and medium-term modeling infrastructure for price forecasting.”

In another interpretation that more closely reflects written sketches by von Braun and Torero (2008, 2009) and Robles, Torero, and von Braun (2009), the “price band” that they mention appears to be irrelevant; indeed, the function of the floor price is not discussed. The “virtual reserve” would apparently adopt no long positions and hold no stocks in normal times but would stand ready to take naked short positions (not backed by stocks or prospective harvests) when a price surge is detected by a global intelligence unit endowed with information about the market or special forecasting powers unavailable to other market participants. The idea is to arrange access to cash reserves to back these interventions, which “will reduce spot prices and should make speculators move out of the market” (von Braun and Torero, 2009, p. 4).

¹⁷ Operation of this large program in futures markets would require ready access to margin financing and could be subject to gaming by traders aware of the program’s operating rules.

That is, the intervention is designed to reduce levels of stocks deemed excessive by the global intelligence unit. This is a puzzling response to propose as a way to address recent price spikes which, as noted, occur only when stocks are at minimum levels relative to supplies available to the market. Nor is it clear why the “global intelligence unit” is assumed to have superior ability to know when the market is not functioning well. Given the multibillion dollar cost, estimated by the proposers (von Braun and Torero, 2009, p. 3) at \$12–\$20 billion U.S. dollars, these questions, and others technical issues¹⁸ must be answered before these proposals can be given serious consideration as policy options.

3.1. What impact does food price have on food security?

Discussions of the recent food market crisis have naturally associated high food prices with food insecurity. However, too little attention has been paid to the nature and quantitative extent of the relationship between the *level* of prices and the *depth* of food insecurity. The analysis has been focused on the volatility of prices and the presence of spikes, often with reference to short-term, intra-seasonal volatility of quoted prices. One problem is that official statistics on prices, as used by analysts, provide only partial information on the conditions of local food markets, lacking the quantity dimension. In other words, if a daily or weekly high price is quoted on a mercantile exchange, with no indication of the amount of commodity being traded in that particular day or week, it is difficult to assess what that implies for the *availability* of food to poor consumers, or for the prices they pay. The high price, especially if the spike only lasts for few days or weeks, might be associated with limited transactions in a thin market. For example, as increasing numbers of exporters restricted access to their markets in 2007/08, they severed the links between the welfare of their domestic consumers and reported prices in global markets. On the other side of the market, major importers including most MENA countries have long insulated much domestic consumption from global volatility of price, and indeed go further, reducing mean prices on much or all of domestic consumption below market levels.¹⁹ The consideration above points to the limitations of inferences relating short-term volatility of prices to consumer welfare in MENA countries. Policy makers should consider whether prices are likely to be

¹⁸ See for example Wright (2009).

¹⁹ For a recent analysis of the link between international price indices and consumption prices in developing countries, see De Hoyos and Medvedev (2009).

allowed to fluctuate with the world market in future periods of market turmoil. If not, budget exposure, and the possibility of actually running out of stocks due to lack of financial resources or foreclosure of timely access to world markets, become the major concerns.

Price stabilization proposals such as those discussed above focus on the “global market,” which is the part of the world market for which prices on the principal grain futures markets are most relevant. As discussed above, in the recent tumultuous years these prices were totally different from those faced by most consumers in developing countries (De Hoyos and Medvedev, 2009).

For MENA countries, stabilization of the international price is less important than, and quite distinct from, local market stability. We now turn to policies related to stability of grain markets in the MENA region. The first question that must be resolved is the objectives of such policies in these countries.

4. Policy objectives of countries in the MENA region and related instruments.

Despite significant reforms in many countries, food subsidies continue to be prevalent in MENA countries, and their funding incurs a significant fiscal burden. They generally make larger per capita transfers to the rich than to the poor, so there is little reason to believe that their major objective is to improve the welfare of the poor. One review has stated that “The resistance to radical food policy reform is [...] due primarily to the fear of civil unrest and its subsequent impact on political stability. Past experience in the MENA region illustrates the potentially explosive nature of food price increases (e.g., Tunisia, Morocco, Egypt, Jordan), substantiating the concerns of policy makers.” (World Bank, 1999, p. 3). If their long-standing policies of subsidization of grain or bread consumption are not subject to abandonment in the near future, the relevant question changes from whether governments should intervene to how they should optimize their market stabilizing interventions, given their political constraints.

4.1. National strategic reserves

One reason that grain prices have not completely reverted from recent peaks is that many countries are rebuilding or expanding their grain reserves in reaction to the export bans and export taxes observed recently.²⁰ In doing so, these countries are indicating that they do not view international futures markets as reliable substitutes for local accumulation of stocks. This is easy to understand in the case of landlocked African countries which rely on transport infrastructure of neighboring countries, and are subject to foreclosure of crucial trade routes just when they are most needed. Futures contracts eliminate counterparty risk with respect to performance of the futures contract, including delivery at the designated delivery point. But for remote countries risks related to other counterparties, including financiers, agents, transport providers, and neighboring governments, remain very important and often impossible to hedge. Further, a futures market might be shut down or exports banned by the host country.²¹

In general the MENA countries are far less remote than landlocked African countries, and are close to major trade routes. It is difficult to imagine that regional events specific to grain markets, such as a local export demand surge due to a drought, could preclude access to imports from afar. A more likely motivation is concern that political or military events could cut off market access. For MENA countries bordering the Persian Gulf, we conjecture that these could include a blockade of the Straits of Hormuz, or other serious military disturbance. For the citizens of Gaza, closure of market access via Israel is a familiar hazard. For Egypt and nearby states, closure of the Suez Canal could also be disruptive to grain imports, at least in the short run. Many MENA countries may believe that crises that disrupt their food imports might also interfere with the flow of oil revenues that fund these imports. This double exposure should loom large in their planning for food and energy security.

A national food reserve is thus an essential element of a prudent national security policy for many MENA countries. The key question, then, is how large the reserve should be. The answer

²⁰ Recent reports indicate that Saudi Arabia, Egypt, Iran, China, Russia, Jordan, Mozambique, Morocco, and Malawi are among the countries placing grain in national reserves. (Marc Sadler, personal communication, April 30, 2009.)

²¹ Both actions were taken in India in 2007 at a time when the situation in world grain markets fell far short of emergency conditions, and even the United States once briefly banned soybean exports, in 1973 under the Nixon administration.

must depend on the facts of each case, including the diversity of food supplies, dependability of traditional suppliers, and cost of the program. Such stocks tie up capital for the substantial intervals between releases and can be expensive to maintain.²² Their efficient management also uses scarce human capital, and temptations for corruption can easily arise.

Two generalizations about the MENA countries are important for the design of their emergency reserves. The first is their extraordinary dependence, as a group, on imported grain for their food supply. The second is their heavy and continuing subsidization of the very grains upon which they are so dependent. The latter suggests the hypothesis that private competitive storage is likely to be unattractive, even in the absence of special stabilization measures. Storage is likely to be dominated by publicly controlled stocks, and perhaps by unknown quantities held by consumers against disruption of the public distribution system. Effects of public stocks on incentives for private commercial storage incentives are likely to be less salient in the design of public storage policy. On the other hand the subsidies encourage excessive consumption of grain products and exacerbate dependence on their importation.

Even though the MENA countries are large importers on the international scene, their aggregate consumption is too small to require them to pay much attention to the effects of their policy choices on the international price, except perhaps with respect to short run purchasing tactics. Thus the national storage activity discussed here is appropriately directed at a stockpile of a certain size deemed appropriate to meet security goals efficiently, relative to alternative policies, rather than aimed at modification of the behavior of prices.

The peculiar circumstances of most MENA countries extends to the nature and attractiveness of major alternatives. The region is mostly dry, and most countries, especially around the Gulf, are relatively unpromising candidates for agricultural expansion. Where irrigation is economically feasible, as in Egypt, the comparative advantage would seem to reside in high-value, labor-intensive agriculture rather than grain production. Nevertheless policy documents of the Arab Economic Summit and of the Arab Organization for Agricultural Development (AOAD) still advocate expansion of grain production as a measure to enhance food security.

²² Stocks would be “rolled over” with no net release as frequently as needed to maintain quality.

In this situation, a major benefit of storage as a security mechanism is that it can substitute for much more costly efforts to expand grain production. Saudi Arabia has recognized the folly of producing grain at a cost five times the prevailing world price, while depleting its scarce supply of fossil water and subjecting its land to the spread of salinity. Storing one or two years' supply in its dry desert climate, though incurring a substantial capital cost, might be a sustainable and far more economical use of its resources than its former production regime. Other MENA countries around the Mediterranean have better agricultural potential but, at the margin, many would be better advised to turn to larger stockpiles rather than expansion of grain production to give them the security they believe they need.

MENA countries that do not wish to subsidize a large portion of food consumption, but instead aim to target the most vulnerable, can design policies to do this, while encouraging participation of the private sector in their grain markets, as discussed at greater length in Wright (2009). Egypt's policy of making coarse *baladi* bread available at a low fixed price is an example of a self-targeting strategy which limits leakage of aid to richer consumers. If public aid is restricted to bread favored only by the poor, it can leave the rest of the market to the private sector except in dire emergencies that are preferably well defined ex ante. The public distribution system can be used as a major part of a strategy to "roll over" strategic stocks, keeping them viable, while minimizing the impact of sales from stocks on the private market.

4.2. Intra-Regional Collaboration

As a complement to national strategic reserves, the possibility of intra-regional trade and regionally coordinated reserves must be considered. Figure 5 shows wheat production in individual countries and in the MENA region as a whole. For each series, the coefficient of variation (mean divided by standard deviation) of deviations from a linear trend is reported in parentheses. The figure shows that pooling the entire regional output variation and sharing it proportionally would stabilize supplies of wheat considerably, especially for countries such as Morocco, Iraq, Saudi Arabia and Tunisia, but they would still need to import large portions of their grain supplies to feed their populations adequately.

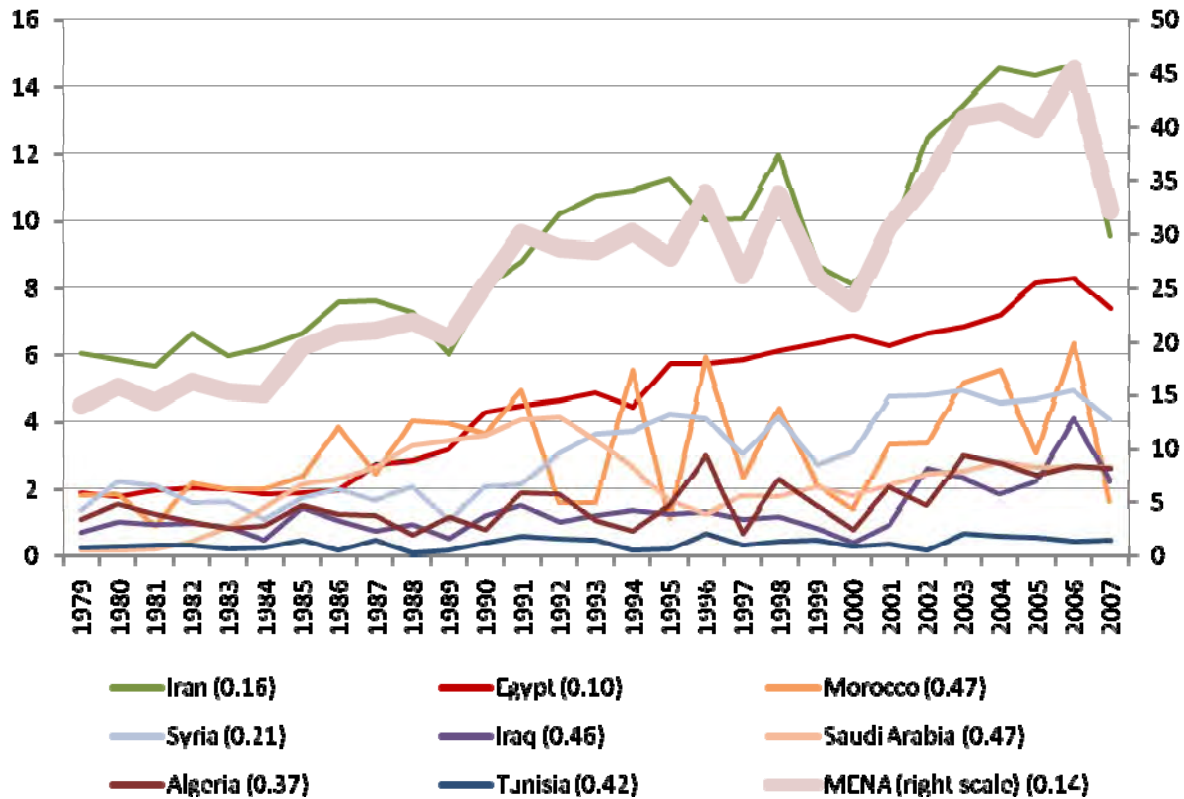


Figure 5
Wheat production in the MENA Region (1979-2009, million ton)
Coefficient of Variation of the series (after de-trending) in parenthesis.
Quantity relative to the entire MENA region are read on the right axis.

As the graphs in Figure , suggests, there is some potential for smoothing of wheat availability in most of the countries in the region by pooling production (the series of aggregate wheat production in the region is smoother than many of the individual countries' components.) To the extent that regional governments can commit to maintain MENA trade access in cases of rising prices, trade within the region should help stabilize local food markets up to the limits imposed by the costs of trading. If the objective is overall market stabilization, then the only commitment which is needed by regional government is that of not to ban food exports. Unfortunately, as argued above, some exporters within the region have displayed a commitment problem in keeping their borders open. When shortages loomed, their own consumers have lobbied successfully to ban or tax exports (as for example in Egypt, Syria, Yemen and Iraq) (World Bank, 2009).

If local shortages are unrelated to global market conditions, so that the exporter commitment problem is less relevant, a regional reserve might be useful in improving the speed and flexibility of short-run responses to local food crises.²³ But its operation poses many challenges familiar to administrators of aid programs, and care must be taken to minimize disincentives caused by the price-depressing effects of food distribution for the local farmers and merchants who, after all, are always the first line of defense against famine for countries where a serious food shortage should occur. For example, measures should be taken to ensure that transport will be available for promptly delivering this aid, and this might be a problem especially for landlocked countries.

It seems likely that direct assistance to the neediest, where feasible, would be more effective than attempting to reduce prices by supplying extra grain to regular food markets. Public employment programs for those needy who are able to work have been successful in cases where it has been possible to keep the reward for work low enough to be unattractive to those with other employment alternatives (Subbarao, 2003; Del Ninno et al. 2009, section III).

4.3. Some logistics considerations

If some MENA countries, such as those around the Mediterranean, feel confident of their access to world grain markets even in emergencies, they can economize by holding lower levels of precautionary security stock. However, for reliable protection against shortages, they will need to ensure that their needy consumers can receive imported supplies when and where they need them. This is more difficult than it seems. The logistical chain for imports can look totally different when it is under delivery pressure. Stocks moved quickly into ports are useless if ships cannot be unloaded or supplies cannot be moved from the port, due to unaccustomed congestion. Under equipment constraints, a normally comprehensive and economical rail system serving a large area with many stations can change into a system with only a few useable stations. These points and others are revealed in the Brennan et al. (1997) study of the West Australian wheat market. Perhaps other more comprehensive studies of emergency logistics are available to MENA countries; if not, this is an area that could merit further work.

²³ Recent difficulties, involving lags in food aid responses, and mismatches between years when aid is plentiful and years when it is needed, might be alleviated by such a reserve.

4.4. Other recent proposals to address price volatility

Besides measures affecting storage activity directly, other policies might be considered to reduce market volatility and/or increase market access. Some of these have considerable merit; others do not. We now turn to several of these, starting with the more promising.

4.4.1. Commitments to divert grains from biofuel and feed uses in emergencies

Modern food markets are, in an important sense, more inherently stable than their predecessors. Now, an increasing portion of food grains and oilseeds is being used for biofuels or for animal feed. While biofuels production is unlikely to be high in the MENA region, animal feeding will rapidly increase as incomes rise. In a food supply emergency, it should be possible for MENA governments to offer contracts to animal feeders in their own countries that commit the latter to divert grains and oilseeds to food use in specified food market emergencies. Such diversion should not only increase food supplies when needed, but has the additional short run benefit of increasing the supplies of meat from animals that would otherwise be kept on feed or used for breeding

4.4.2. Investment in foreign land

This strategy has been pursued mostly by oil rich Arab Countries (Gulf Countries and Libya) to address long term food security while recognizing that self sufficiency is not an option and in an environment in which there is growing concern on the reliability of free international trade.

After an initial surge of purported deals, the rush towards foreign investments in land seems to be subsiding. The reduction of food prices from their peaks of 2008, the onset of the financial crisis with associated credit restrictions,²⁴ and growing concerns about the effects of some of the announced deals on the welfare of the local farmer communities, have meant that some of those deals have either been delayed or abandoned. Nevertheless, there is still a strong interest in investment in foreign land. Sudan and Pakistan are the nearby countries most attractive to Arab investors. Sudan in particular is well placed geographically to be a long term supplier of Gulf

²⁴ At the 5th World Islamic Economic Forum in March 2009, for example, the Binladin Group decided to stall its plan to invest \$4.3 billion in rice production in Indonesia as a result of the global financial crisis (Smaller and Mann, 2009, p.4).

States and Egypt. At present, however, Sudan cannot even feed its own population. It could definitely benefit from properly arranged and selected foreign agricultural investment. The fundamental obstacles to such deals may be lack of adequate infrastructure and property rights, and underdeveloped legal systems of the countries involved.

4.4.3. Commitments to refrain from using export restrictions

Recent experience in the rice market has demonstrated the hazards associated with reliance on imports to satisfy needs for a staple commodity. Exporters and importers have a joint interest in keeping trade open when prices are high so they can together reap the full benefits of the smoothing role of trade, which can exceed what can be achieved via storage. But commitments of governments beyond the term of the current administration are difficult to achieve and can easily collapse when governments face pressure from politically powerful urban consumers. One useful policy change to improve the commitment capacity of exporters would be a reform of WTO disciplines on export bans and export taxes consistent with existing rules against import tariffs and quotas. However some observers note that such a discipline, even if agreed, would have little power in an emergency since WTO sanctions do not apply retrospectively.

4.4.4. Oil for food arrangements

According to a recent report, the United Arab Emirates, presumably capable of offering a logical food-for-oil deal, were unable to obtain blanket assurances from Pakistan that grain produced from the Emirates' planned agricultural projects in that country would not be subject to export controls.²⁵ However it should be possible to structure such projects as an "oil for food" exchange that increases the security of both parties. Similar deals might be struck to induce biofuel producing countries to divert grain to human use in emergencies, compensated by a promise of oil from a MENA source.

4.4.5. Conditional trade agreements: food for water

One of the consequences of the recent soaring prices of cereal grains and other agricultural commodities in the context of water scarce Arab countries is that it exacerbates the problems of

²⁵ Oxford Analytica, *Global Strategic Analysis*, April 20, 2009.

water scarcity to the extent that such high prices – as can be expected – will create additional incentives towards production and export of irrigated crops.

In this respect, the case of the Syrian Arab Republic (SAR) and Turkey offers an interesting example. For years, SAR has been engaged in negotiations with Turkey over the distribution of water flows of the rivers that originate in Turkey and flow through Syria. The major issue concerns the Euphrates river, on which an agreement exists according to which Turkey should guarantee a flow of 500 cm/sec at the border with Syria (Varela-Ortega and Sagardoy, 2001, 2003). Recent droughts, however, have repeatedly revealed the incompleteness and the weakness of the current agreement. When the Euphrates basin has received less-than average inflows, especially during the summer, Turkey has reduced the amount of water flowing to Syria, claiming that the agreement ought to be intended as based on an average flow across the year, whereas Syria maintains that the 500 cm/sec should represent the minimum guaranteed flow.

The negotiations are proceeding, although, to our knowledge, no explicit link has ever been made between these negotiations and the type and volumes of commodity trade between the two countries. This situation makes for an interesting case where water and grains trade agreements can be combined in defining a risk sharing arrangement between the two Countries with mutual advantages.

The essential elements of one possible conditional trade agreement are reported in the Appendix. The main message is that, by being creative and focusing on the real issues at stake, mechanisms like the one envisaged may address food security without stressing the water scarcity problem. In short, the mechanism will allocate water to its best user, and will prevent that precious water would be “wasted” in Turkey when it would be socially very valuable in Syria.

5. Conclusions

The storability of grains causes the price response to a change in supply to vary with the level of available supply. The major grains —wheat, rice, and maize— are highly substitutable in the global market for calories. When their aggregate supply is high, a modest reduction can be tolerated with a moderate increase in price by drawing on discretionary stocks. But when stocks decline to a minimum feasible level, the price becomes much more sensitive to small net shocks.

In a free market, poor consumers may be forced by high prices to spend much of what resources they have on food and reduce consumption at great personal cost. Others reduce consumption very little even when prices soar.

In 2007/08 the aggregate stocks of major grains carried over from the previous year were at minimal levels due largely to substantial mandated diversions of grain and oilseeds for biofuel and strong and sustained increases in income in China and India. Lack of stocks rendered the markets vulnerable to modest but unpredictable disturbances such as regional weather problems, the further boost to biofuel demand from the oil price spike in 2007/08, the unprecedented extension of the long Australian drought, and other production problems. However, supplies in the market were sufficient to meet food demands without jumps in price, had exporters not panicked, leading to a cascade of export bans and taxes that cut off importers from their usual suppliers.

These events of 2007/08 understandably forced MENA countries to focus on their vulnerability to continued turmoil in grain markets. The recent Russian production drop due to drought and fire, and the subsequent export ban, can only reinforce their concern with reliance on global markets to ensure national food security. In choosing policies, each country needs to consider carefully what it defines as adequate food security, in light of its resource endowments and the tradeoffs presented by different policy options.

In general, accumulation of stocks is a more effective and much less costly strategy than attempting to achieve grain self-sufficiency. On the other hand, investment in foreign land for grain production is unlikely to solve the problem of unreliability of access to imports in emergencies, which has been made manifest in the actions of many exporters in the past few years. Finally, countries might wish to consider seriously whether a policy that highly subsidizes grain consumption even of wealthy citizens and discourages control of waste and diversification of calorie sources is worth its price in terms of budget expense and greater dependence on foreign supplies of one or two grains.

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Appendix: elements for a possible grain-for-water agreement between the Syrian Arab Republic and Turkey

The essential elements of a possible conditional trade agreement between the two countries are the following: At the beginning of the season, Turkey transfers X metric tons (mt) of wheat (barley, sorghum, millet or any combination) to Syria. During the season, the flow of water at the Turkey-Syrian border is monitored. If the flow is reduced below Y cm/sec for a total of N or more days during the season, Syria is entitled to keep the stock of grains without payment to Turkey. If, instead, the minimum flow is guaranteed, Syria pays Turkey the average world price of wheat, gross of interests accrued and, possibly, of a risk premium. The amount of wheat transferred from Turkey to Syria acts as a “collateral” paid by Turkey to guarantee Syria on the adherence to the agreed upon minimum flow of water, and it ensures that water in wheat production will be used most in the Country where that is most efficient.

The model is built on the assumptions that:

- a) In “normal” years, the water released to guarantee the minimum flow has a zero opportunity cost for Turkey (the parameter X can always be defined in such a way that this condition is true);
- b) In “normal” years, and without policy distortions, Turkey would export and SAR would import wheat (in other words, it is assumed that Turkey holds a comparative advantage with respect to SAR in terms of wheat production.)

The agreement would specify the parameters X , Y and N to a mutual advantage, which will surely exist, given the contract structure, as long as there is a difference in the marginal value of water in the two countries. To understand this point, consider the following. In normal years, there will be no loss to either party by maintaining the minimum flow throughout the season: only a regular trade of wheat from Turkey to Syria is established. In a drought year, Turkey might find convenient to cut the water below the minimum guaranteed flow only if the shadow value of water in wheat production in Turkey is so high as to justify foregoing the returns on the wheat

stock used as “collateral”. If the value of water in Turkey, even in a drought year is lower than it is in Syria, it will be convenient for Turkey to “sell” the marginal water to Syria and not forego the payment of the collateral wheat. On the other hand, if Turkey decides to keep the precious water, Syria will have the minimum stocks needed to guarantee food security in the country, which would have been procured at minimal cost.

The structure of incentives of such an agreement will depend on the relative value of water in the two countries, which, in turn, depends on the rainfall conditions in the two countries. Syria currently uses most of its water resources to produce wheat and cotton. Also, given problems with current irrigation practices, the consumption of water is quite high. This means that the amount of wheat-equivalent to ask as a guarantee against the water deficit might be sensibly lower than what Turkey might be losing in guaranteeing the agreed upon minimum flow of water. Syria will face the risk that the price of grains increases when there is a drought and yet Turkey fulfills the minimum guaranteed flow, but this risk could be relatively easily hedged on the global markets by trading futures on wheat.