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Jayati Ghosh, James Heintz and Robert Pollin

October 2011

WORKINGPAPER SERIES

Number 269

POLITICAL ECONOMY RESEARCH INSTITUTE

Gordon Hall
418 North Pleasant Street
Amherst, MA 01002

Phone: 413.545.6355
Fax: 413.577.0261
peri@econs.umass.edu
www.umass.edu/peri/

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October 2011

Jayati Ghosh
Professor of Economics,
Jawaharlal Nehru University, New Delhi, India
and Executive Secretary,
International Development Economics Associates (IDEAs)

James Heintz
Research Professor
Political Economy Research Institute (PERI)
University of Massachusetts-Amherst

and

Robert Pollin
Professor of Economics and
Co-Director of the Political Economy Research Institute (PERI)
University of Massachusetts-Amherst

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JEL Codes: G01, G12, G18, Q18

Abstract

In December 2010, the FAO food price index surpassed its previous peak of June 2008, and prices have been maintained at this high level through September 2011 (i.e. as of this writing). This pattern in food prices is creating justified fears of a renewal or intensification of the global food crisis. This paper reviews arguments and evidence to inform current debates on how to regulate commodity futures markets in the face of such price volatility and sustained high prices, focusing on 1) the relationship between market liquidity and price patterns in asset markets in general and commodities futures markets in particular, and 2) the relationship between spot and futures market prices for food. We find that there is strong and consistent evidence in support of the need to limit the huge increases in trading volume on futures markets through effective regulations. We also find that the opposite position—i.e. the main analytic arguments opposing market regulation—cannot be supported by the evidence. That is, we find no support for the claim that liquidity in futures markets serves to stabilize prices at their "fundamental" values or that spot market prices are formed free of any significant influence from futures markets. Given these results, the most appropriate position for regulators to assume at present is a precautionary principle: they should enact and enforce policies capable of effectively dampening excessive speculative trading on the commodities markets for food.

INTRODUCTION

There is deepening concern about high and extremely volatile prices of food in international trade markets. In December 2010, the FAO food price index surpassed its previous peak of June 2008, and prices have been maintained at this high level through September 2011 (i.e. as of this writing). This pattern in food prices is creating justified fears of a renewal or intensification of the global food crisis. As a result of the food price spike in 2008, a United Nations study estimated that approximately 130 million more people experienced malnutrition throughout the developing world (Sheeran 2008).

Moreover, it is now increasingly clear that that the global food crisis is not a matter that can be treated as unrelated to the global financial crisis. On the contrary, the rise in food prices and the financial crisis are intimately connected, with the channel of influence running from the massive increase financial speculation in food commodities on the commodities futures markets to both high volatility and sustained high levels in the world price of food.

This is not to deny the undoubted role of other real economy factors in affecting the global food situation. While demand-supply imbalances have been touted as reasons, this is largely unjustified given that there has been hardly any change in the world demand for food in the past three years. In particular, the claim that food grain prices have soared because of more demand for food from China and India as their GDP increases, is completely invalid, since both aggregate and per capita consumption of grain have actually fallen in both countries. Supply factors have been – and are likely to continue to be – more significant. These include the short-run effects of diversion of both acreage and food crop output for bio-fuel production, as well as more medium-term factors such as rising costs of inputs, falling productivity because of soil depletion, inadequate public investment in agricultural research and extension, and the impact of climate changes that have affected harvests in different ways. Another important element in determining food prices is oil prices: since oil (or fuel) enters directly and indirectly into the production of inputs for cultivation as well as irrigation and transport costs, its price tends to have a strong correlation with food prices. So curbing volatility in oil prices would also help to stabilize food prices to some extent.

Despite all these factors, it is clear that the recent volatility in and current high levels of world trade prices of important food items cannot be explained by real demand and supply factors. In this article, we examine two questions that are at the center of the debate on the relationship between the activities of traders on the commodities futures markets and volatile movements up and down of global food prices. The first issue is the relationship between market liquidity and price stability in asset prices in general, and commodities futures markets in particular. The second is the relationship between movements of food prices in spot markets and futures markets. Obtaining a clear understanding on these questions is crucial for understanding the policy debates on how to regulate commodities futures markets for the purpose of stabilizing global food prices. They also provide a broad analytic framework for more formal econometric studies on these topics that we are currently developing.

THE RELATIONSHIP BETWEEN MARKET LIQUIDITY AND PRICE STABILITY IN ASSET MARKETS

We address this question both through an overview on the relationship between liquidity and stability in asset markets generally and commodities futures markets in particular.

To begin with, liquid asset markets—i.e. markets with a relatively large volume of trading opportunities—clearly provide a benefit to wealth holders through enabling them to buy or sell claims on physical assets without having to make long-term commitments to holding these assets. Thus, because the New York Stock Exchange is thick with millions of traders, it is easy for any of us to buy shares of, say, Microsoft tomorrow if we wish to then sell those same shares two days later. The physical plant, day-to-day operations, and profit prospects of Microsoft will almost certainly not have changed over the course of those two days. But because of the existence of a highly liquid stock market, we have nevertheless been able to become both an owner and former owner of the firm in that short time period. Depending on activity in the market, we may even be able to receive some capital gain through this short-term purchase and sale of Microsoft shares.

The parallel situation also holds with the futures market for food commodities. When there is a highly liquid market for food commodities, a farmer can choose when to relinquish her ownership claims on the crops she is cultivating, rather than bear the risk of waiting until the crop is harvested. Without a relatively liquid market for food commodities delivered in the future, farmers would be forced to bear the risk of waiting until the harvest to sell their crops, at a price in the spot market that nobody can know for certain in advance.

These benefits of liquid asset markets, including commodities futures markets, are not in dispute. However, proponents of the "efficient market" theory of how asset markets operate contend that the benefits of liquid financial markets extend well beyond this basic contribution. Moreover, any full assessment of highly liquid asset markets must consider their costs as well as the benefits we have described.

Efficient market theory of liquid asset markets

According to the efficient market approach, liquid capital markets correctly evaluate firms according to their "fundamentals"—i.e. their potential profitability. Thus, a liquid financial market is engaged in crucial information processing and price discovery activities. The profit potential of firms becomes widely disseminated as a result. Moreover, the fact that information on fundamentals is widely disseminated forces firms to operate more efficiently. It becomes more difficult for firms to hide their deficiencies, and these deficiencies are widely recognized and punished by market participants.

Correspondingly, capital market traders are rewarded for trading at prices that reflect fundamentals, and are punished for trading at prices that misread fundamentals. Over time, in other words, good traders outcompete bad traders, and the most important characteristic of good traders is that they will end up driving prices toward fundamentals. It follows from this perspective that any significant interference with the market that diminishes liquidity, and thereby trading levels, will be harmful. Similar

arguments are made for commodity futures markets, with the fundamentals being the real economy factors which drive supply and demand. For the specific case of commodities futures markets, the argument would be that any regulations to discourage market trading would diminish the capacity of markets to establish prices that reflect fundamental values. [1]

Critique of the efficient market hypothesis and alternative perspectives

The efficient market hypothesis—and specifically the argument that increasing the liquidity of markets must be stabilizing—has been heavily criticized, starting with John Maynard Keynes himself in his classic 1936 work, *The General Theory of Employment Interest and Money*. But the critical tradition developed beyond Keynes in various ways, continuing into the present. The range of leading critics has included the late Hyman Minsky, Andrei Shleifer, Robert Shiller, and the Nobel Prize winning researchers George Akerlof and Daniel Kahneman.

As one important stream of alternative thinking, Shiller (1989, 2005) and Akerlof and Shiller (2009) emphasize the role of investor psychology, independent of individual firm fundamentals, as a major determinant of asset market prices. As Schiller writes regarding equity markets, stock prices "change in substantial measure because the investing public en masse capriciously changes its mind" [1989, p 1]. Shiller's book, *Irrational Exuberance* (2005) as well as Akerlof and Shiller's updated study *Animal Spirits* (2009) examine in detail the social and psychological "anchors" that determine stock market prices beyond what might be explained by fundamentals. These "anchors" include a strong desire to accept evidence that could earn traders lots of money. Moreover, because these and related anchors are fragile by their nature, they are liable to unexpected and sometimes rapid reversals. In Schiller's view, this explains the fact that the stock market and other asset markets fluctuate to a degree well beyond what can be explained by fundamentals.

Related to Schiller's critique are arguments about the centrality of asymmetric information in financial markets, and specifically the influence exerted by ill-informed "noise traders." For example, in Shleifer's [2000] presentation of the "behavioral finance" perspective, he models financial markets as containing two kinds of traders: fundamental traders and noise traders. But noise traders are not competed out of the market by the fundamental traders in this perspective. This is because arbitrage is risky, costly, and therefore limited. For example, if asset prices are inflated relative to fundamentals, arbitrageurs who chose to sell short face potential losses from prices moving still higher under the influence of noise traders—that is, their short-selling will not necessarily drive prices down to fundamentals. Thus, the actions of noise traders are not merely ephemeral to market activity, but rather exert a sustained influence on price formation.

A deeper point about the nature of asset markets also emerges from this perspective. As Keynes and Minsky emphasized, if markets are persistently and unpredictably moved away from fundamentals

[1] The modern statement of the efficient market approach begins with Milton Friedman's 1953 paper "The Case for Flexible Exchanges Rates," and was developed further by Fama, Jensen and others. See Fama's 1970 paper for a sympathetic review of the empirical evidence and Hubbard (2008) for a standard sympathetic textbook treatment.

by noise traders, it no longer becomes logical for even well-informed traders and professionals to try to trade on the basis of fundamental information. It rather follows that professional traders should proceed as Keynes argued, to trade by trying to outguess market sentiment, moving ahead of the herd by "anticipating what average opinion thinks average opinion to be" [1936, p. 156]. As such, one might even argue that while "fundamentals" such as the costs of producing commodities as well as the global demand for consuming the commodities certainly exist as factors in setting prices, they do not exist as the sole "fundamental" basis on which prices are formed, when markets are driven by what average opinion thinks average opinion will be.

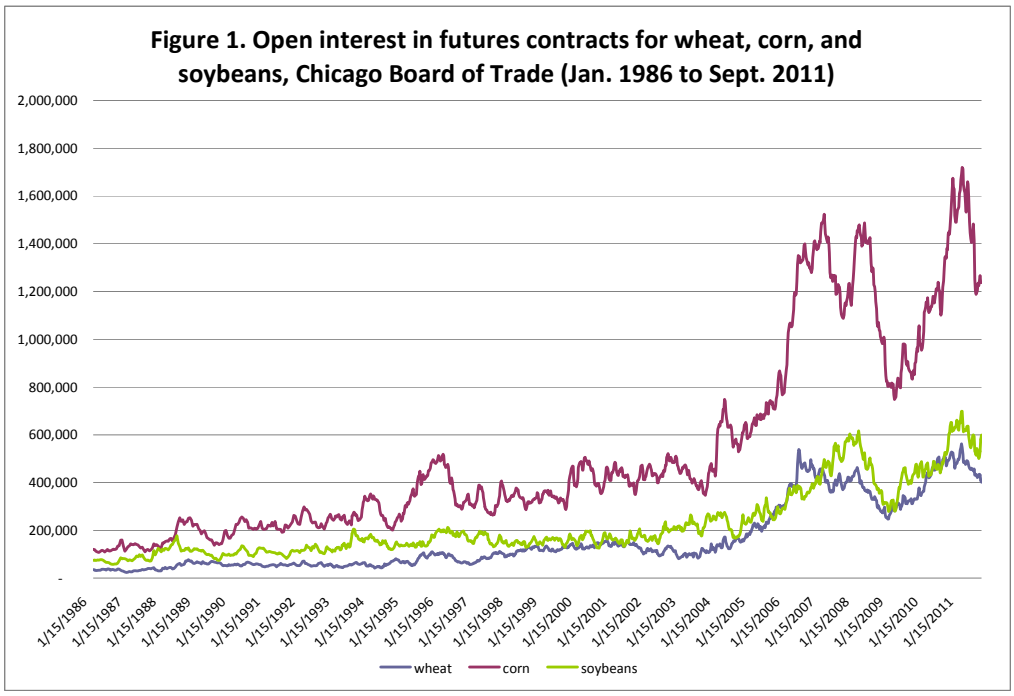
When commodities futures markets operate under these conditions, a final crucial implication follows. That is, since markets can be moved away from fundamentals by various types of trading strategies—e.g. through buying or selling ahead of the herd—it follows that large-scale traders may be able to move the markets in directions that are favorable to themselves. Moreover, if one trader controls a disproportionate share of the overall market, this will facilitate any efforts to push the market in their favored direction. For example, if Goldman Sachs controls, say, 20 percent of the open interest in the wheat futures market, that means they can move ahead of the herd in shaping the direction that the market takes. They have the resources to initiate an upward price bubble, and they can then also be the first to start selling short before the herd movement reverses itself.

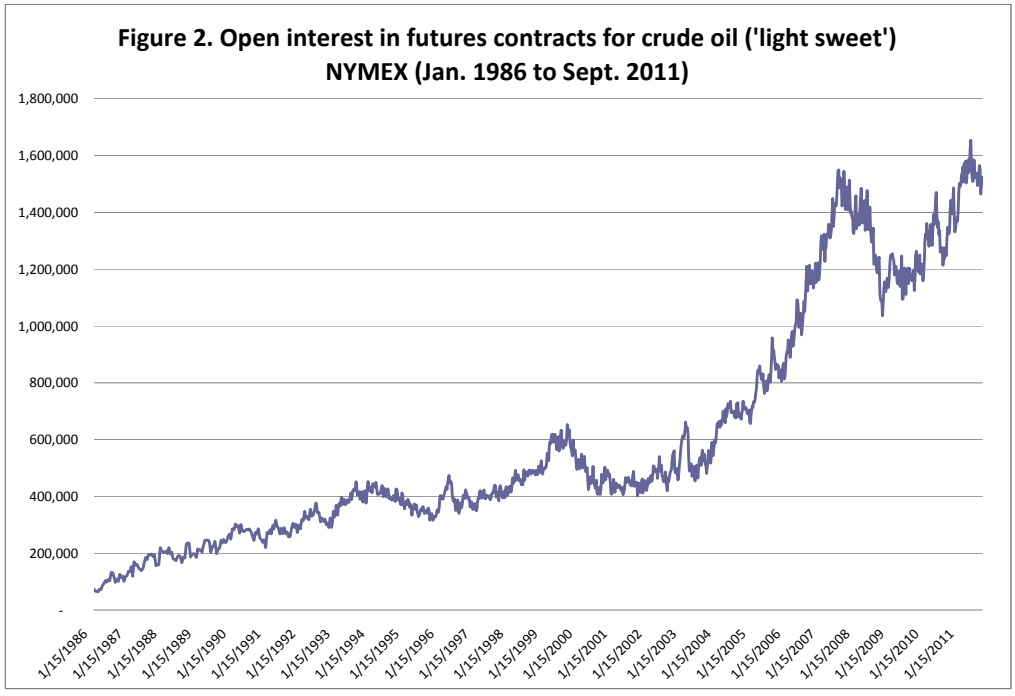
It was precisely to guard against this type of market bubble dynamics that regulations of these markets have included position limits as one important measure. Position limits are, straightforwardly, limits on the total proportion of contracts within a market that can be held by any one trader. Of course, if increasing the liquidity of markets always drove prices toward fundamentals, as argued by proponents of efficient market theory, then it would not matter what share of the market any one trader, Goldman or otherwise, was able to control.

EVIDENCE ON RISING LIQUIDITY, PRICE LEVELS AND VOLATILITY IN COMMODITIES FUTURES MARKETS

Liquidity and rising price levels

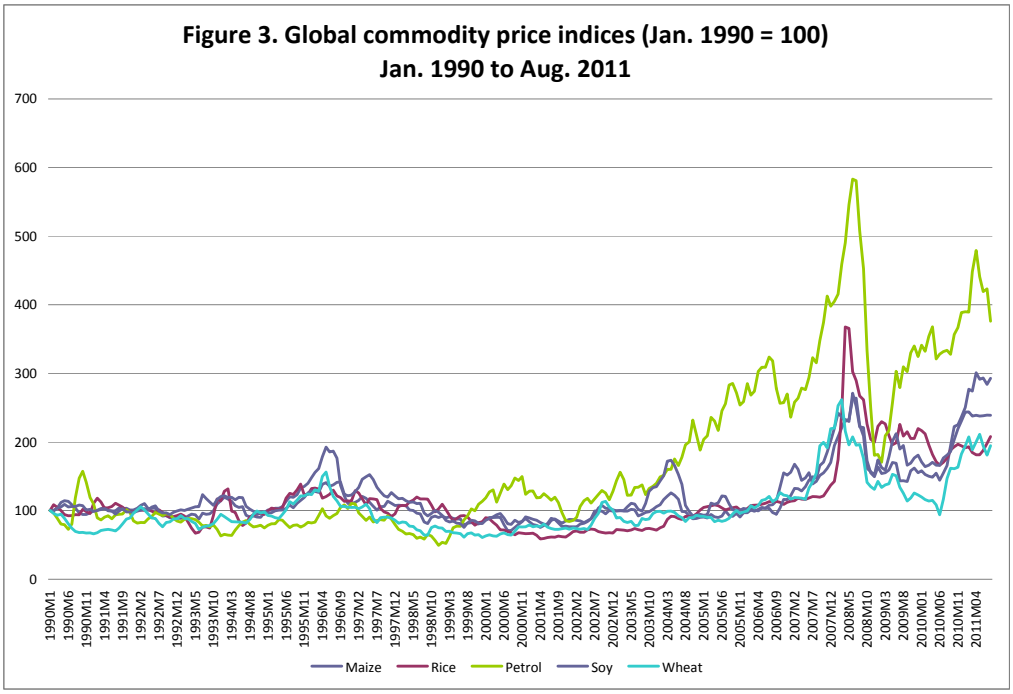
A reasonable standard measure of liquidity in commodities futures markets is the *open interest* in any particular commodity market. The open interest in futures markets refers to the number of contracts which have not yet been fulfilled through delivery. Figure 1 shows the open interest for three futures markets at the Chicago Board of Trade - wheat, maize (corn), and soybeans from 1986 to 2011. Figure 2 shows the open interest in crude oil on the NYMEX market. In all cases, open interest (i.e. liquidity) begins to increase around 2003/4. There is a short-lived reduction in open interest during the financial crisis which began in the second half of 2008, but open interest has since recovered. The increase is particularly noticeable with regard to the corn and crude oil markets.





It is useful to compare these changes in liquidity with the price dynamics in spot markets. Figure 3 does this over the period 1990 to 2011 using indices of global commodity prices for wheat, maize (corn), rice, petroleum, and soybeans. The price indices for all commodities take on the value of 100

in 1990. The increased liquidity in the futures markets which began around 2003-04 is associated with very rapid commodity price inflation, with most commodity prices peaking in 2007-08.



That is, there is a strong and obvious correlation between the increase in liquidity in these commodity futures markets and the rapid rise of prices in spot markets. But observing *correlation* is not the same as explaining *causation*. We have not yet developed a fully worked out explanation as to the various causal channels operating in these markets. For now, we can conclude that other potential causal influences, including a) shifts in global supply and demand in spot markets; and b) the rising demand for food commodities as biofuels are not themselves large enough in magnitude to explain the huge run up in prices.[2] Equally, they are not close to being large enough to explain the volatility in prices taking into account the periods of both increasing and falling prices.

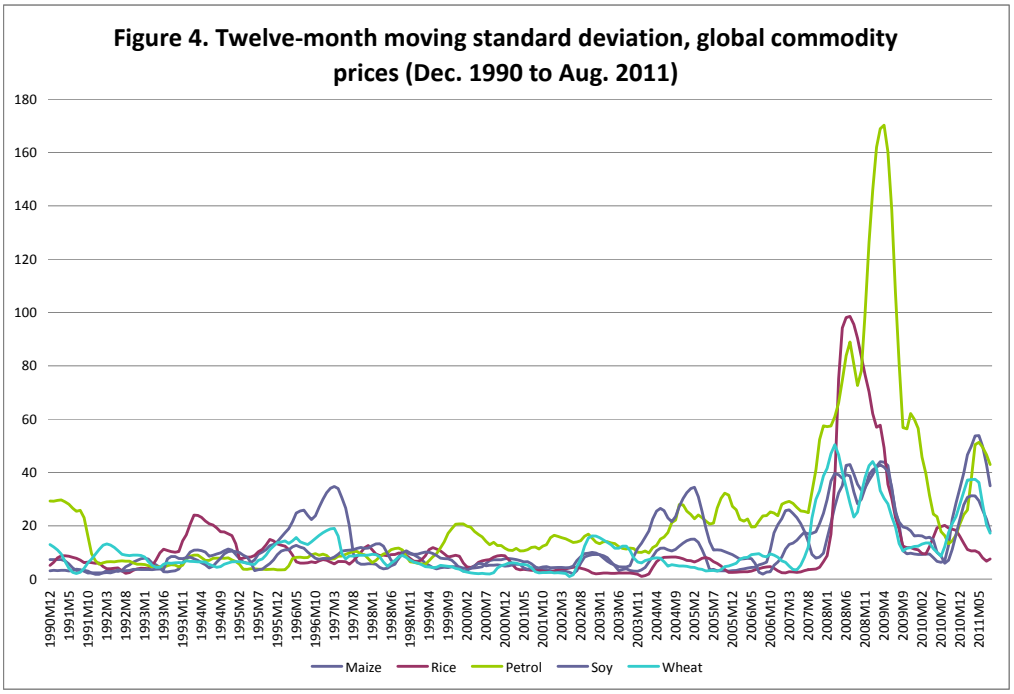
Liquidity and price volatility

The sharp increase in the trend of food prices is not the same as *volatility* in these prices around their average value. Volatility refers to significant swings in prices over time around an average value. Prices can be volatile around a constant average price; and similarly, markets can experience price inflation—a rise in the trend of the average price—while volatility can remain at a low level.

Has volatility in spot markets increased with liquidity in future markets? The short answer is "yes." But how much volatility has increased—in particular, as distinct from the run up in the average price—depends on how one measures volatility.

[2] See Ghosh (2010, 2011 for details).

The most common way to measure price volatility is through the standard deviation around the average (mean) price level.[3] In Figure 4, we plot the standard deviation of the price indices over the previous 12 months as an indicator of historical volatility of these prices. The standard deviation data presented in Figure 4 are derived from the price level figures presented in Figure 3.

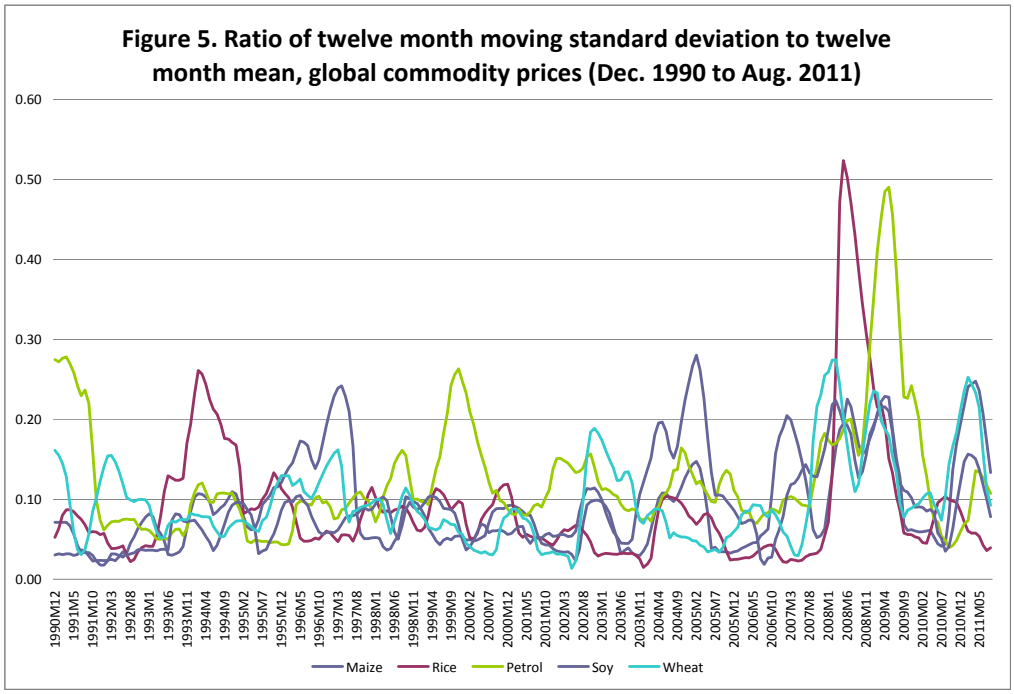


We see in Figure 4 that the standard deviations of these commodity price indices vary within a fairly constant range up until early 2007. We make two observations based on this chart:

1. Volatility was relatively steady prior to the significant increase in liquidity. That is, there is no indication that price volatility in spot prices was heightened due to the low levels of market liquidity relative to the most recent years; and
2. The highest levels of volatility are associated with the rapid increases in liquidity towards the end of the period.

But in considering these results, it is important to also recognize that this measure of volatility is sensitive to the fact that, as we have observed above, the average price level also rose dramatically. If we are interested in observing changes in volatility by themselves, as distinct from the change in the average price, we need to modify our calculation of volatility. We can control for the effects of changes in average price through dividing the standard deviation by the average of the price indices over the same 12 month period. Figure 5 shows how using this modified measure of volatility alters the results.

[3] The standard deviation of a variable and its variance, are both measures of the dispersion of a variable around its average (mean) value. The variance of a variable is the expected value of the square of the deviation of the variable around its mean value. The standard deviation is the square root of the variance.



Thus, using this measure that isolates the effects of volatility from the rise in average prices, we see that volatility was significant in the 1990s. Volatility is then tempered somewhat from 2000-2006. However, again, even with this measure, volatility rises sharply again starting in mid-2007.

The reasons for the difference in this pattern relative to that which we observed in Figure 4—when we do not control for changes in the average price—are straightforward. The average prices were substantially lower during the earlier period. Thus, all else equal, any measure of volatility which adjusts for changes in the average price level will indicate greater volatility when prices are low, than when prices are high.

This raises an important concern about volatility indicators and how we interpret them relative to broader economic and social implications. Volatility is most often measured, explicitly or implicitly, relative to the mean or average value of a variable. But what happens when the mean value of the variable changes over time, as has occurred recently with commodities prices? In such cases, a focus on volatility alone, independent of the rise in the average price, can divert attention from the fact that the average price is rising. As such, it is crucial that we consider both the sharp increase in average prices along with the volatility around the rising average price as the combination of changes that we need to examine.

Overall findings from review of evidence

We can conclude the following from this brief examination of the relevant evidence:

1. There is no evidence that prices on the food commodities markets that we observed behaved in a more volatile way when the markets were *less liquid*—i.e. when the open interest in the various markets was lower. At the very least, we can conclude that the dramatic rise in market liquidity is not associated with a lessening of price volatility.
2. There is clear evidence showing that the rise in market liquidity is associated with very rapid increases in spot market prices. Yet we also emphasize again, at this point, that we are referring only to correlations between rising liquidity and spot prices, without trying to sort out as yet the various causal channels.
3. The rapid increase in prices is also associated with the most rapid increases in price volatility, as measured by standard deviations around average prices. The sharp increase in the average price also creates more room for large fluctuations around the average price.
4. In considering the evidence on price volatility independently of the rise in average prices, we still observe that price volatility starting in mid-2007 is at least as strong, if not stronger, than any previous time during our full sample of years. As such, all evidence points to the conclusion that the recent sharp increase in market liquidity is associated with high levels of price volatility.
5. Analyzing the change in spot market prices entails that we consider together both the rapid run-up in the average prices along with the absence of any dampening of volatility due to the rise in market liquidity.
6. Overall then, we can conclude confidently at this point that:
    a. The liquidity of the food commodities futures market that we have observed increased dramatically starting in the early 2000s, and especially from 2007 onward.
    b. This rapid rise in liquidity was associated with a similarly rapid increase in average prices; and
    c. By one common measure of volatility, the rise in liquidity was also associated with a rapid increase in volatility. But even considering alternative measures of volatility, there is no evidence that the rise in liquidity is associated with a dampening of volatility, and there is still strong evidence that the rise in liquidity is associated with higher levels of volatility.

CHANNELS OF INFLUENCE BETWEEN SPOT AND FUTURES PRICES

Thus far, we have been considering broad patterns in the futures and spot markets for food commodities. But we have not explicitly examined how the interconnections operate between these two markets. In this article, we are not prepared to offer a full explanation of these interconnections. But we can offer some thoughts and evidence that may be of use.

To begin with, the movements of spot and futures markets are clearly connected because both are influenced by market supply and demand influences. Over the long run, spot and futures prices cannot move in completely independent ways—i.e. one being completely independent of supply and demand forces. If this were to happen, it would create huge opportunities for traders to arbitrage between the markets. Such opportunities would themselves serve to close the gap between spot and futures prices.

The question on which we wish to focus is more complex—i.e. the extent to which speculative movements of futures prices can themselves influence spot prices. This would entail forces that are largely independent of "fundamental" supply and demand influences. These are forces operating primarily within the futures markets, exerting influence on spot prices. Clearly, the specific consideration we have in mind here is the extent to which speculative activity on futures markets, driven by the huge rise in market liquidity, acts to influence spot prices. We have already seen the clear correlation between the rise in futures market liquidity and the rise in both the level and volatility of spot prices. The question is that of the mechanisms through which futures prices can drive spot prices higher.

Since the vast majority of futures contracts are settled independently of the physical delivery of goods, some researchers argue that there is no necessary channel through which futures prices will affect price determination in spot markets. For example, this is the basic conclusion that flows from the influential working paper by Irwin and Sanders (2010) written for the OECD.[4] Moreover, the supply of futures contracts is not constrained by the supply of the physical commodities. The number of contracts (i.e. open interest) can increase without limit, as long as there are willing buyers and sellers. Therefore, the dynamics of supply and demand in the two markets are distinct. Futures markets, along with spot prices, are clearly influenced by supply and demand fundamentals, but the futures markets themselves do not have a separate set of "fundamentals" rooted in the real, non-financial economy.

The primary way in which futures prices can have a direct impact on spot prices is by influencing expectations of price changes and movements in supply and demand. Researchers connected to the US Department of Agriculture have argued that futures prices perform well as price forecasts for spot markets over reasonably short time horizons (e.g. Hoffman and Balagtas, n.d.). If traders in spot markets use futures prices to form expectations of how prices will move in the future, then futures markets can have a direct impact on current prices in spot markets. That is, the futures markets are providing information to spot markets through which appropriate prices—i.e. prices governed by supply and demand forces—are "discovered." Indeed, the rationale for regulating futures markets in the first place was because of concerns that excessive speculation in futures markets could lead to distorted information that would in turn destabilize the process of price discovery governed by sup-

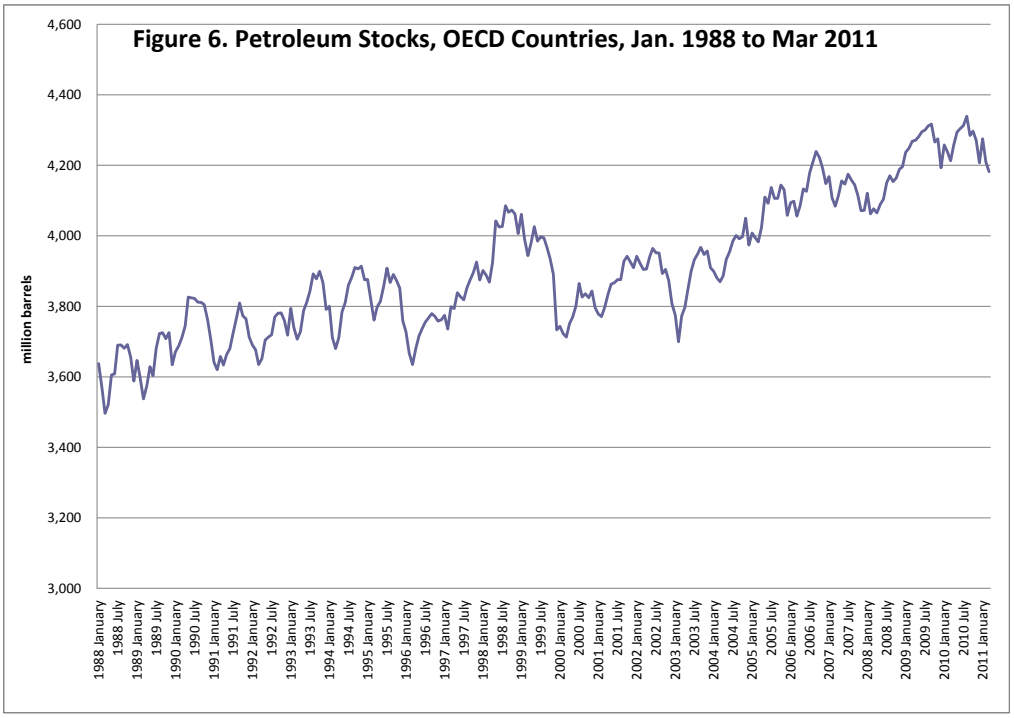
[4] Irwin and Sanders appear to subscribe to a version of the efficient market hypothesis, in which speculative trading in futures markets cannot impact spot markets. Future prices do affect spot prices, but only to the extent that they contain additional information about fundamentals , and in this way facilitate price discovery. But this implies that any effect futures markets can have on spot markets must be based on fundamentals and not speculative behavior. The only scope for a speculative impact in their approach appears to be through a modified version of the 'noise trader' argument. That is, inexperienced traders mistake price movements in futures markets as representing information about fundamentals. But they dismiss this as a possibility since markets are driven by the decisions of "sophisticated and experienced traders." See pp.7-8 of their paper.

ply and demand. For example, position limits in futures markets were established as a regulatory tool to guard against any large trader exerting excessive influence in setting futures market prices, which would then disrupt the spot markets.

Observing futures market effects on spot markets

One indicator that futures prices are influencing spot prices is a build-up of inventories when both spot prices and futures prices are increasing. The reasoning is straightforward: if suppliers in spot markets expect prices to increase in the future, they may withhold their products from the market in order to profit from higher prices in the future (the amount withheld depending on storage costs and discount rates). The withdrawal of supply then pushes up prices in spot markets. Note that a build-up of inventories when spot prices are increasing must be driven by expectations, and not fundamental shifts in supply and demand. The explanation for increasing inventories during times of rising prices is that prices are expected to be even higher in the future.

In the case of petroleum markets, the data on inventories supports the above argument that expectations play a significant role. Figure 6 shows monthly petroleum stocks in OECD countries from 1988 to 2010 (May). Beginning in 2004, there is a sustained upward movement in oil stocks. Specifically, oil stocks were increasing during the period of significant price hikes in world petroleum markets. This evidence supports the idea of price increases being driven, at least in part, by speculative dynamics—that is, suppliers withholding petroleum from spot markets in order to profit from higher expected prices in the near future.



Future market impacts without inventory fluctuations

There is also evidence of rising inventories for some food commodities—including wheat, rice and coarse grains—especially during the most intense period of speculative activity in futures markets in 2007-08. But the broad pattern with food inventories is not as consistent as what we observe with oil.

However, there is a more basic point to emphasize here, which is that inventories do not necessarily need to change in order for futures prices to affect spot markets. Assume that futures prices are used to form expectations about the direction of price changes. If the expectation is that prices will increase in the future, suppliers will only be willing to sell on the spot market at a higher price than they would in the absence of such expectations. This is because traders in the physical commodity could always hold onto their stocks and sell them at some point in the future.

It is also the case that purchasers may be willing to pay a higher price than they would have if prices were not expected to rise. The logic here is similar to that with suppliers. Individuals guard against future price hikes by buying now rather than later. In terms of supply and demand in the spot market, expectations that are formed through the futures market could thereby cause demand to increase for a given price and the supply to decrease for this same given price. The result is an unambiguously higher spot price. Note also that the impact of the higher spot price depends on the relative response of demand and supply to changing price expectations. If the impact on demand is greater than that on supply, it would then be clearly possible for spot prices to increase in response to changes in futures markets, while, concurrently, inventories are falling.

Granger tests for spot/future market causal relationships

Overall then, there are reasons to anticipate that spot prices influence futures prices and futures prices influence spot prices—that the channels of influence run in both directions. It must also be accepted that the direction of causality can change over time. One way in which we can formally explore the extent of this possible two-way causal relationship is through the technique of Granger causality testing. The Granger causality test enables one to examine the extent to which, over time, and through various specific time sequences, spot and futures market price movements exert influence on each other.

For example, Hernandez and Torrero (2010) used Granger causality tests to analyze the dynamic relationship between spot and futures prices using data on weekly returns and weekly volatility for maize, hard wheat, soft wheat and soybeans. They found that changes in futures prices lead changes in spot prices more often than the reverse. They argue that this may be related to the fact that the information flow from futures to spot markets has increased, due to the increase in the relative importance of electronic trading of futures contracts over open auction trading. UNCTAD (2011, page 7) notes that “On the whole, prices on futures exchanges are much more transparent than those in spot markets, which are comparatively opaque.... It is therefore not surprising that futures markets play such a vital role in commodity price discovery.” The point is that when these markets are themselves affected more significantly by speculative forces than by “real” market fundamentals, they give what

may be seen as "wrong" or at the very least, confusing, market signals to those engaged in actual production and consumption of these commodities.

CONCLUSIONS

Overall then, considering both our discussions on market liquidity and price patterns and on the relationship between spot and futures market prices, there is certainly strong and consistent descriptive evidence in support of the need to limit the huge increases in trading volume on futures markets through effective regulations. At this point, we can also state that the opposite positions—i.e. the main analytic arguments opposing market regulation—cannot be supported by the evidence. That is, the arguments and evidence we have reviewed regarding the rise in liquidity futures markets offer no support for the claim that more liquidity in futures markets serves to stabilize prices at their "fundamental" values. They similarly provide no support for the claim that spot market prices are formed free of any significant influence from futures markets.

In the face of another looming food crisis similar to 2008—that is, the prospect that tens if not hundreds of millions of people throughout the developing world could experience malnutrition due to excessively high food prices—a straightforward policy position emerges from our findings. That is, the most appropriate position for regulators to assume at present is a precautionary principle: they should move as expeditiously as possible to enact and enforce policies capable of effectively dampening excessive speculative trading on the commodities markets for food.

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