A simple price monitoring tool to assess monthly changes in food prices

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Introduction

Food prices have always been volatile, but they may become even more volatile in the future given the new linkages between oil and grain prices. These new linkages are due to several factors that have converged in the past few years. While technologies that can convert grains to fuel have existed for some time, it is only recently that they have become profitable enough to create a stronger link between oil and grain prices than has existed in the past. In addition to improvements in biofuel technologies, policies in several developed countries (e.g. mandates, tariffs) have also played a key role by lowering the level of oil prices at which this linkage becomes operable. Finally, developments in supply and demand in world oil markets also play a role: if oil prices are at a relatively high level in the medium term due to continued economic growth in developing countries and increased difficulties in finding new cheap sources of supply, this makes it easier for grains to be competitive as a source of fuel, providing yet another reason why there are likely to be stronger linkages between grain prices and oil prices.

The linkage between oil prices and grain prices serves to increase demand for grain, leading to higher grain prices than would otherwise be the case. Along with declining cereal yield growth rates (at least for rice and wheat) and continuing rapid economic growth in developing countries that leads to diversified diets and creates additional feed grain demand, there is reason to believe that world grain prices will be higher in the next decade than they were in the late 1990s and early years of this century.

Perhaps more important than the additional demand, however, is the fact that oil prices have historically been much more volatile than grain prices. If grain prices are linked to oil prices, then we would expect that grain prices will be more volatile than they have been in the recent past, and indeed, volatility in grain markets has increased in the past two to three years (changes in futures markets regulations may have also played a role). If world grain prices remain volatile, this will present a major policy challenge to developing countries that want to protect their farmers and consumers from price surges that have serious effects on income distribution, investment and nutritional outcomes.

Market prices are critical sources of information for policymakers. They aggregate and integrate the information held by millions of economic agents, including their expectations regarding likely short-term developments in supply and demand. For example, if farmers and traders in a particular region notice that the crop is not developing well, they may try to increase stock levels in anticipation of further price increases. This behavior will influence market prices and send signals to other traders in other regions. Of course, markets do not work perfectly, but nevertheless prices are extremely valuable sources of information about expectations of the future. Furthermore, prices can be observed on a frequent basis (in contrast to estimates of production). Because they can be observed frequently and contain so much information, prices are powerful tools to assess the state of food security on a short-term basis for both farmers and consumers.

This paper presents a simple tool that can be used to monitor developments in market prices. The data requirements are relatively simple: all that is needed are monthly data on nominal market prices and the consumer price index (CPI). At least seven years of data are highly desirable, although it is possible to work with less depending on market dynamics. Given appropriate data, the price monitoring tool can be used for any level of the marketing system (farm, wholesale, retail). It can also be used for any type of food commodity, although staple foods such as rice, wheat and maize are the most likely candidates because of their importance to large numbers of farmers and consumers.

The price monitoring tool can be implemented and automated in any basic spreadsheet. The final output is a graph that shows past trends in prices as well as "benchmarks" for future price developments. Before discussing this output and its interpretation, the paper will describe the spreadsheet calculations that are done to monitor price developments.

The spreadsheet calculations[1]

In general terms, the price monitoring tool tries to alert users to situations when prices are changing (increasing or decreasing) relatively quickly after taking into account seasonality and inflation. In some cases, this will be obvious, and the price monitoring tool is redundant. For example, if rice prices increase in one month by 30% in a country where annual inflation is about 10%, then such an increase is clearly much more rapid than is normal. In other cases, however, the conclusion may not be so obvious. For example, if rice prices increase or decrease by 2% in a particular month, is that too rapid or about normal? The price monitoring tool described in this paper should be helpful in such ambiguous situations.

The example will use data on retail wheat flour prices in Kyrgyzstan (National Average Prices). The Excel file is divided into several sheets. The first sheet is the "Instructions" sheet, where the user could find information on how to operate the tool. The second sheet is "Data" The first two columns of the "Data" sheet (A and B) are the month and year, column C is the nominal price (data), and column D is the consumer price index, or CPI (data). These are self-explanatory (because they are data, not calculations). However, in some cases it may be necessary to perform calculations to estimate missing CPIs. For example, in the example that is used in writing this paper, as of August 2012, the International Monetary Fund (IMF) had reported the Kyrgyz CPI up to (and including) April 2012. Therefore, CPIs from May 2012 to August 2012 have to be estimated in order to keep the model updated.

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[1] Please refer to the spreadsheet "Price Monitoring Tool-Kyrgyzstan Wheat Flour Retail" posted along with this paper

For the May 2012 CPI, the estimate is calculated as the April 2012 CPI times the average monthly inflation during the past 12 months, which is calculated as (April 2012 CPI/April 2011 CPI) raised to the power of (1/12). Thus, the May 2012 CPI is estimated as:

May 2012 CPI = April 2012 CPI *(April 2012 CPI/April 2011 CPI)$^{(1/12)}$
June 2012 CPI = May 2012 CPI *(April 2012 CPI/April 2011 CPI)$^{(1/12)}$
July 2012 CPI = June 2012 CPI *(April 2012 CPI/April 2011 CPI)$^{(1/12)}$
August 2012 CPI = July 2012 CPI *(April 2012 CPI/April 2011 CPI)$^{(1/12)}$

which explains the formula in cell D89. Cells D90, D91, and D92 are calculated in a similar manner, but are done by estimating the CPI for June, July, and August 2012.

The third sheet is the "Calculations" sheet. Column E in this sheet reports the real price. The real price adjusts nominal price data for inflation. It is calculated as the nominal price times a ratio of CPI index numbers. For example, to calculate the July 2005 wheat flour price in August 2012 som, multiply the July 2005 nominal price times a ratio. This ratio is the CPI in August 2012 divided by the CPI in July 2005. What does this ratio tell us? The ratio of two CPI index numbers tells us the factor by which prices have changed between the two time periods. In Kyrgyzstan, the CPI in July 2005 was 99.8, while in August 2012 it was 196.5. Taking the ratio of these two numbers gives 195.9/99.8 = 1.9629, which means that, on average, prices of most commodities were 1.9629 times higher in August 2012 than in July 2005. This can be considered the impact of monetary policy, which allows prices of nearly all goods and services to increase over time. Thus, if the fundamental wheat flour market conditions of July 2005 (including population, weather, demand, supply, and world market conditions) were to exist in August 2012, when prices were 1.9629 times higher than in July 2005, the price of wheat flour would be equal to 14960 soms per ton (the nominal price in July 2005) times 1.9629 or 29362 soms per ton. This compares to the August 2012 price of wheat flour of 27500 soms per ton. Thus, measured using the value of som in August 2012 (which are much less valuable than soms in July 2005), we can see that wheat flour is cheaper in August 2012 compared to July 2005.

Before moving to column F in the "Calculations" sheet, we will present one more example of a real price calculation; calculate the August 2008 wheat flour price in August 2012 som (this example is not shown in the figures). First, let us take the ratio of the two CPI index numbers. Since the CPI in August 2008 was 148.3, and the CPI in August 2012 was 195.9, the ratio is equal to 1.3210. This means that the prices of most goods and services in August 2012 were 1.3210 times as high as in August 2008, or 32.1% higher. Thus, if the wheat flour market conditions of August 2008 (including population, weather, demand, supply, and world market conditions) were to exist in August 2012, when general prices were 1.3250 times higher than in August 2008, the price of wheat flour would be equal to 30370 som per ton (the nominal price in August 2008) times 1.3210, or 40122 som per ton[2]. This compares to the August 2012 price of wheat flour of

[2] There may be some differences between the numbers reported here and the numbers in the reference excel file due to rounding as not all digits could be reported here. Therefore, if the reader would like to check

27500 soms per ton. Thus, measured using the value of som in August 2012 (which are less valuable than som in August 2008), we can see that wheat flour was more expensive in August 2008 compared to August 2012.

Column F in the “Calculations” sheet is a moving average of real prices from column E. For example, the moving average for September 2005 is calculated as the average of prices in all 12 months between mid-March 2005 and mid-March 2006. For any given month, it is just an average of the surrounding 12 months. The price in the first and last months are divided by 2 in order ensure that the month for which we are calculating the moving average is placed in the middle (please see the formulas in column F). It is called a moving average because the months used to calculate the average move, or change, as the month for which the average is being calculated changes. For example, the moving average for October 2005, just one month later, is the average of prices in all 12 months between mid-April 2005 and mid-April 2006. Notice that the months used to calculate the average move forward one month as the calculation moves forward one month from September to October. Why calculate a moving average? Please see the notes for Column G.

Column G is the ratio of the price in any particular month to the moving average price for that month. This is the first step in calculating a seasonal factor. This ratio tells us how high or low the price in a particular month and year (e.g. March 2006) was compared to the price in surrounding months. For example, the ratio for March 2006 is equal to 0.9777. This tells us that the real price in March 2006 (26161 soms per ton, som being August 2012 som) was 2.23% lower than the average price between mid-September 2005 mid-September 2006 (which was 26759 soms per ton).

Column H calculates the seasonal factor for each month. It is the average of the ratio column (column G) over the past seven years for the same month[3]. Thus, cell H86 calculates the average of the past 7 ratios for the month of February. You can confirm that all cell references in cell H86 = (G14+G26+G38+G50+G62+G74+G86)/7 refer to the month of February, i.e. G14 is February 2006, G26 is February 2007, G38 is February 2008, and so on. The following table shows the value of the ratio in each of the 7 cells noted above.

Cell Address	**Date**	**Ratio**
G12	February 2006	0.9780
G24	February 2007	0.9855
G36	February 2008	0.9239
G48	February 2009	0.9493
G60	February 2010	0.9709

these calculations and reach exact numbers, please refer to the excel file that this paper refers to (please see footnote 1).

[3] Due to lack of data beyond January 2005, the seasonal factors for the months of March, April, May, June, and July are based on six years. The seasonal factor for the other months is based on a seven year average. The model will be updated accordingly as new data come in on the wheat flour price in Kyrgyzstan so that the seasonal factor for all months would be based on seven years of ratios.

G72	February 2011	1.0018
G84	February 2012	0.9443

On average, real prices in February are about 3.52% less than real prices in surrounding months. This is the seasonal factor for February, 0.9648.

Columns I and J make a very minor adjustment to the seasonal factors calculated in column H in order to calculate the normalized seasonal factor. By definition, the average of the 12 seasonal factors for the 12 months should be exactly 1.00, which means that the sum of the 12 seasonal factors should be exactly 12.00. However, for the seasonal factors calculated in cells H75 to H86, the sum is equal to 11.9552 (see cell I86). Thus, in order to create the normalized seasonal factors, it is necessary to multiply all the seasonal factors in column H by the ratio of 12/11.9552 to create the normalized seasonal factors in cells J75 to J86. Notice that the normalized seasonal factors in column J are almost identical to the seasonal factors in column H. This is because the ratio of 12/11.9553 is almost equal to 1 (it is equal to 1.0037).

Column K just copies the nominal price data from column C.

Column L calculates the prices that would have prevailed if prices had been at normal levels (calculated as the average real price over the past four years[4]) and had followed normal seasonal patterns. In cell L87, corresponding to March 2012, this is calculated as =AVERAGE($E$39:$E$86)*J75, where J75 is the seasonal factor for March and average ($E$39:$E$86) is the average real price from March 2008 to February 2012. The product of these two factors is a real price in terms of August 2012 som. It is now necessary to convert this to a nominal price in terms of March 2012 som, so that it can be properly compared with the nominal price in March 2012. In order to do this, multiply by the ratio of two CPI index numbers, the CPI in March 2012 divided by the CPI in August 2012. This ratio of two CPI index numbers is equal to 196.8/195.9, or 1.0046, and this ratio is multiplied by the other two factors noted above. The rest of the cells in column L are calculated in similar fashion.

Columns M, N and O are benchmarks of future prices in the “Calculations” sheet. They are calculated by multiplying the current price (in this case, August 2012) by three factors: one for seasonality, one for inflation, and one for uncertainty.

The first factor is a ratio of normalized seasonal factors (or simply seasonal factors). For the September 2012 price, it is the September seasonal factor divided by the August seasonal factor. In this particular case, the September seasonal factor is 1.0346, while the August seasonal factor is 1.0228. This means that real prices in September are typically above real prices in August. Taking this into account means that we must multiply the August price by 1.0346/1.0228 = 1.0115

The next step is to multiply by an inflation factor because we expect prices to increase every month due to general inflation. The inflation factor is just the average monthly

[4] The choice of four years is arbitrary. Other numbers could also be used.

inflation factor during the past 12 months, which is calculated as = $(195.9/194.9)^{(1/12)}$ = 1.000432. Thus, after multiplying the August 2012 price by 1.0115 due to seasonality, we multiply by 1.000432 to obtain 27830 som/ton.

The final factor is the uncertainty factor, designed to take account of the fact that prices do not always behave according to normal seasonal patterns. While the seasonal patterns calculated in column J are real patterns, they are averages and are not followed every year. For example, it was noted earlier that real prices in September are usually 1.15% higher than real prices in August (thus, the factor of 1.0115). However, September prices are not 1.15% higher than August prices every year; if this were true, it would be easy to predict prices. Sometimes, the September price might be 3% higher, while at other times it might be 5% lower than the August price. The uncertainty factors are generated using country and commodity specific price data, and estimates of these factors for a given commodity in a given country should not be used for other commodities or other countries. The uncertainty factors are calculated so that prices should fall between the low and high benchmarks about 70% of the time. The other 30% of the time, prices will fall either above the high benchmark or below the low benchmark. The choice of 70% is arbitrary (the user could alter it based on his/her knowledge of the market for a given commodity), and other cutoff points could be used (cutoff points could be modified by changing the value of cell H1 in the "Data" sheet).

The first step in calculating the uncertainty factors is to calculate, for historical data, the absolute value of the difference between: (i) the percentage change in real prices between two adjacent months; and (ii) the difference in seasonal factors between those same two months (these numbers are shown in column I of the "Deviation" sheet). This gives an estimate of how much a given historical price change (say between July 2005 and August 2005) differs from what would be expected due to normal seasonal patterns. This calculation is done for seven years of data, which gives a total of 84 deviations from normal seasonal patterns. These 84 deviations are then ranked from smallest to largest, and the percentage change given by the 59th (59/84 = 0.70) observation becomes the uncertainty factor because the deviation from normal seasonal patterns is less than this amount 70% of the time. In this particular case, for wheat flour in Kyrgyzstan, the uncertainty factor is about 3.55%. Thus, the benchmark price of September 2012 (27830 som/ton) is multiplied by 1.0355 and 0.9645 to determine the upper and lower bounds of the uncertainty band. This same procedure is repeated for price differences between months that are two months apart, e.g. October to August, and for price differences between months that are three months apart, e.g. November to August.

Columns M and O also contain the uncertainty band for the previous six months (bold numbers in black: Rows 87 to 92). These numbers show up on the graphical output to illustrate whether actual past prices have exceeded the upper and lower bounds in previous months.

In column Q and U cells Q87:Q92 and U87:U92 are previous months' benchmark prices.

In column R cells R87:R92 show the percentage deviation of the actual price from the benchmark set by the model. The blue number indicates that the deviation has been within the uncertainty band (hence expected). The black numbers indicate that the deviation has been outside the uncertainty band.

<u>An example of graphical output</u>
Once the future price benchmarks have been calculated as described above, it is possible to create a graph similar to Figure 1.

The left hand side of Figure 1 has four price patterns. One is the actual pattern of nominal prices (the blue line) during March to August of 2012 – these are just raw data. The other pattern (the red line) shows what prices would have been if they had followed normal seasonal patterns at a level equal to average real prices during the past four years. In other words, the red line is the average price which takes seasonality and inflation into account. In this particular example, the average prices during the past four years are higher than the actual prices observed today. The average past prices (red line) increase from July to August due to seasonal factors.

The two grey lines are the uncertainty band from the previous months. They are there to show whether the observed price for that month was too high or too low (i.e. outside the uncertainty band) relative to the established benchmark for that month. In this case only the price in August increased "too much" but the other months were inside the band.

The right hand side of Figure 1 shows three levels of benchmarks for the evolution of future prices: middle, high and low. The middle benchmark show how prices will evolve if normal seasonal patterns are followed and inflation remains in line with experience during the past year. Of course, this pattern will almost never be achieved exactly in the real world. Thus, the high and low benchmarks are presented to give some boundaries to what is "normal" and what is "abnormal." As mentioned earlier, the definition of what is normal is arbitrary; here, normal is taken to mean 70% of the time.

If prices are changing within the 70% band, then it likely means that conditions in food markets are relatively stable. If, however, prices are above or below the 70% band, then it indicates that somewhat unusual events are taking place and it is worth the attention of policymakers to understand what factors are causing this situation and how it might be remedied. The price monitoring tool is not capable of understanding why prices are moving the way they are; however, it is capable of alerting users to situations when something unusual is taking place.

As a final note, it is worthwhile pointing out that this is not a price forecasting tool except in a very simple sense. For example, if prices go outside the 70% band, it does not indicate that the tool is doing a bad job. Rather, it indicates that there are unusual market developments. Similarly, if prices are inside the 70% band, it does not indicate that the tool is successful. Rather, it indicates that markets are behaving in a relatively normal fashion. Indeed, the tool is constructed so that actual prices will fall outside of the band 30% of the time. Such events are to be expected, but when they occur, it does indicate the need for policymakers to obtain more information about the causes underlying the state of food markets.

Figure1. Retail wheat flour price trends and benchmarks in Kyrgyzstan, 2012