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# Characteristics of International Grain Price Movements under the High Oil Prices

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## 原油価格高騰下における国際穀物価格動向の特性

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　各穀物の国際価格は2008年初頭から上昇を始め，最高値を更新し続けた．価格の高騰には多くの要因が推測されるが，トウモロコシ（コーン）がエタノール生産に利用されるようになってからは原油価格の高騰が主要因である可能性が高いことが本研究により強く示唆された．2007年7月2日から2008年8月4日までの穀物価格（コメ，コーン，コムギ，ダイズ）と原油価格の毎日の終り値をシカゴ商品取引所およびニューヨーク・マーカンタイル取引所からそれぞれ入手し，最小2乗法による回帰分析を行い，原油価格と穀物価格との日々の連動性を分析した．分析の結果，原油と各穀物の価格変動には有意性1％レベルの正の関係がみられた．エタノールの利用が少ないコメとコムギにおいて将来の国際価格の低迷を防ぐためにも将来はバイオ燃料に活用されることが重要になるのではないか．

## 1. Introduction

"Food prices have been steadily decreasing since the Green Revolution, but the days of falling food prices may be over," (von Braun, 2008). Monthly price data, collected through price quotations by Chicago Board of Trade, indicated that average yearly prices of rice, corn, wheat and soybeans have drastically increased from the beginning of 2006 to 2007 at the increasing rates of 30%, 73%, 91% and 49%, respectively. However, that was not an end, because prices of these commodities continued skyrocketing and then made all-time high records in 2008.

The oil prices (WTI) steadily increased since its fall in January 2002 at US\$19.48/barrel to US\$74.40/barrel in July 2006. The oil prices, since then, slightly fell by January 2007, which was also a start for an unforeseeable rise of oil prices in 2007 and up to early July 2008. The record high price of oil was US\$146.07/barrel on July 3, 2008, which was equivalent to the increasing rate of 151% since January 2007.

The high price of energy may be a key factor for rising food prices. Energy and agricultural prices have become increasingly intertwined (von Braun, June 12, 2008). This research attempts to determine the relationships between international grain prices and the oil prices.

## 2. Characteristics of global grain price movements

Global grain prices including rice, corn, wheat and soybeans made all-time high records in 2008. However, the record high prices of grains were made at different times from each other. This situation implied that the global grain prices generally fluctuated together indicating that those major grain crops are competitive crops in planting areas and substitutes with one another in consumption. However, within a year, their price movements of each crop are unique. Figure 1 shows that wheat prices made their high records in the end of February and early March 2008 before a drastic drop-off, whereas rice prices made their records toward the end of April 2008. It is a two-month lag between wheat and rice which are two main staple food of the world population. Rising prices of wheat became a factor shifting consumer preference for consuming more rice by reducing wheat consumption. In addition, increasing demand for bio-fuels from grains has been emerging close price movements between oil and corn and soybeans which are widely being used as feedstock for bio-fuels in America and some countries in Asia such as China, Japan, and bio-diesel in Europe, respectively. The trade-off between food and bio-fuels which

is becoming stronger for corn and soybeans has been putting a strong upwards pressure on prices of other grains like rice and wheat.

Seasonality, adverse weather and imposition of policy by major producing and exporting countries were also key factors affecting the movements of global grain prices. This trend was seen more clearly in the case of rice and wheat which used to be mainly influenced by the global supply and demand. Export restrictions such as imposition of export tax by Argentina on March 11, 2008, together with drought in Northern China and extreme weather in the U.S. appeared to have a strong influence the skyrocketing prices of wheat in early March 2008. New crops of wheat came in May in the Northern hemisphere and November in the Southern hemisphere. This makes prices of wheat fluctuate every half year. Series of export bans and tax impositions by major rice producing and exporting countries, including India, Vietnam, Cambodia, and China were also the main reason for soaring of rice prices from February to June 2008, during which rice prices slightly decreased due to bumper crops in May and June 2008. Cases for corn and soybeans, as feedstock for bio-fuel production, were
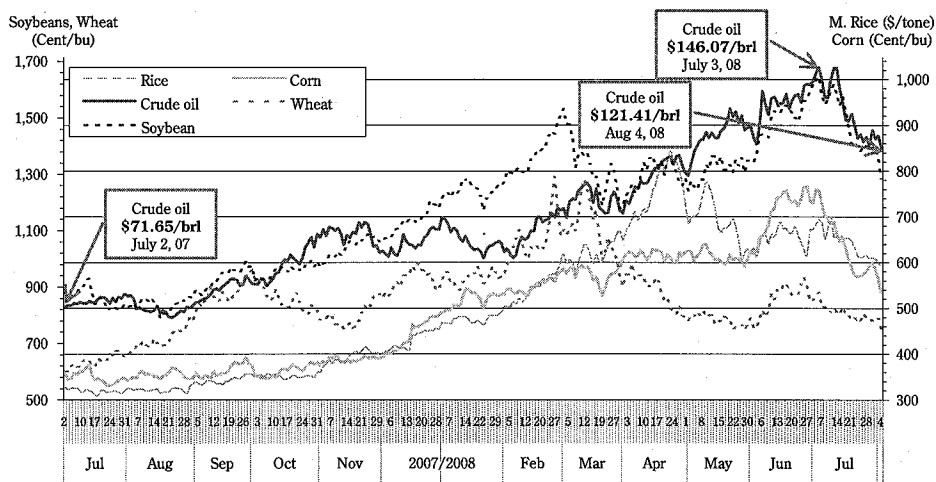


**Fig. 1. Daily Price Movements of Oil, Rice, Corn, wheat and Soybeans in the U.S.**

Rice prices are reported on original website in the rough rice basis in unit of US$/cwt. Milled rice price data were calculated from equation: Original data multiplied by 1000/(45.36*0.6) for 1 ton, which implies approximately equivalent to 4-percent-broken milled-rice package for U.S. No. 1.

Source: GFT—Online Futures Trading, http://futures.tradingcharts.com

slightly different since the oil prices had great impacts on prices of these two grains. Rising demand of corn and soybeans for bio-fuel production made prices of these grains in the global market stably and continuously increase along with oil prices. However, flooding in Midwest of the U.S. in early June 2008 drastically pushed up prices of corn, wheat and soybeans, and prices of corn and soybeans made all-time high records in early July 2008.

## 3. Data and methodology

Data on daily basis were collected from price quotations by Chicago Board of Trade (CBoT) for food commodities including rice, corn, wheat and soybeans and from New York Mercantile Exchange (NYMEX) for oil prices, WTI (West Texas Intermediate) in the period from July 2, 2007 to August 4, 2008. Price data are future prices which are supposed to have slight changes due to demand and supply in the global market. The data set used for analyses in this research was adjusted with all those changes by the authors aiming to achieve the consistency.

The Ordinary Least Squared (OLS) was employed as an analytical method in this research in order to define the relationships of grain and oil prices shown as follows:

$$P_{it} = f(P_{oilt}, X_{sit}),$$

where,

P$_i$:　Daily prices of food commodities, US$/cwt for rice, US$/bu for corn, wheat and soybeans;

P$_{oil}$:　Daily oil prices, US$/barrel;

X$_{si}$:　Other variables, such as dummy and trend variables;

i:　Food commodities; and

t:　Period from July 2, 2007 to August 4, 2008.

Some dummy and trend variables were used in the analyses to include other factors which also influenced the grain prices in addition to oil prices only.

## 4. Results and discussion

Time-series price data for grains and oil were used in the statistical analyses. In the model, grain prices are the dependent variables, and oil price is employed as an independent variable. This model was applied for all grains including rice, corn, wheat and soybeans. However, oil prices were not the only factor affecting prices of the grain crops; therefore, various dummy and trend variables which represent other factors were also used in the model in order to achieve the actual relationships between grain and oil prices.

Other variables, including intercept dummies, slope dummies and trend variables, were also employed as independent variables in the models. In the case of rice, trend variable expressed in a form of squared-root, RTDRICQ, was applied during the period from April 24, 2008 to August 4, 2008 to indicate the increases in rice output in the global markets due to new crop pulling down rice prices. Also two intercept dummies, SDVXP and DTHS, were added to the analytical model for rice to evaluate impacts from export restrictions by Vietnamese government in March and April 2008, and selling out of rice from the stock by Thai government in early May 2008.

Decreases in corn prices in October and November 2007 were represented in the model by a slope dummy, SDCRNQ; on the contrary, an intercept dummy, DJAN1-415, was also used in corn prices as a result of low global reserves, flooding in the U.S. main corn producing states such as Illinois, Missouri, Ohio, Indiana, Michigan in the spring and rising demand for bio-fuel production.

In the analytical model for wheat, RTDWHTQ representing new crop during the period from February 28, 2008 to August 4, 2008, three slope dummies were also employed for the duration from July to September 2007 aiming to include the U.S. lowest ever ending stock at 49% in 2007 to a year earlier[1], extremely hot and dry weather conditions in Southern Europe and Australia, and the U.S. wheat becoming more attractive due to weakening U.S. currency. Furthermore, an intercept variable, DEXRSTR, was additionally applied in the model for wheat to capture the effects from the export restrictions by some countries as reasons for the immediate price hikes in only some days in February and March 2008.

For soybeans, only one trend variable was employed

**Table 1. Results of the regression analyses of rice, corn, wheat and soybean prices relative to oil prices**

| Variable | Rice | Corn | Wheat | Soybeans |
|---|---|---|---|---|
| POIL | 0.180 | 5.15 | 4.41 | 10.1 |
| | (0.00)*** | (0.08)*** | (0.56)*** | (0.18)*** |
| RTDRICQ | −0.341 | | | |
| | (0.06)*** | | | |
| SDVXB | 0.0340 | | | |
| | (0.00)*** | | | |
| DTHS | 3.33 | | | |
| | (0.31)*** | | | |
| SDCRNQ | | −0.700 | | |
| | | (0.05)*** | | |
| DJAN1_415 | | 67.7 | | |
| | | (3.97)*** | | |
| RTDWHTQ | | | −26.3 | |
| | | | (3.30)*** | |
| SDJL07 | | | −2.00 | |
| | | | (0.25)*** | |
| SDA_S07 | | | 0.440 | |
| | | | (0.23)* | |
| SDJ_MR08 | | | 1.81 | |
| | | | (0.12)*** | |
| DEXRSTR | | | 156 | |
| | | | (28.67)*** | |
| SDSBNSQ | | | | 1.99 |
| | | | | (0.10)*** |
| Intercept | −4.06 | −20.5 | 490 | 122 |
| R-squared | 0.917 | 0.950 | 0.757 | 0.923 |
| Adjusted R-squared | 0.915 | 0.950 | 0.752 | 0.922 |
| Durbin-Watson stat | 0.254 | 0.265 | 0.249 | 0.233 |
| No. observations | 276 | 276 | 276 | 276 |

1. *, **, ***: 10%, 5%, 1% significance levels, respectively
2. ( ): Standard errors.
3. Data are daily basis from Chicago Board of Trade (CBoT) for the food commodities and from New York Mercantile Exchange (NYMEX) for the oil prices, WTI (West Texas Intermediate) during Jul 2, 2007 to August 4, 2008.
4. Variables are as follows: rice prices=rough rice $/cwt; corn, wheat and soybeans prices=$/bu; crude oil prices=WTI $/barrel.
5. Dummy and trend variables employed in the analyses are explained as follows:
RTDRICQ: Trend variable for new crop season of rice expressed in square-root from April 24, 2008 to August 4, 2008,
SDVXB: Intercept dummy variable for Vietnamese rice export restrictions from March 17 to April 23, 2008,
DTHS: Intercept variable for pumping up the domestic supply through selling 2.1 million tons of rice from storage by Thai government in early May, 2008,

SDCRNQ: Slope dummy variable for new crop of corn from October 1, 2007 to November 30, 2007,
DJAN1-415: Intercept dummy variable used for corn from January 1, 2008 to April 15, 2008,
RTDWHTQ: Trend variable for new crop of wheat expressed in square-root from February 28, 2008 to August 4, 2008,
SDJL07: Slope dummy variable used for wheat during the period in July 2007,
SDA_S07: Slope dummy variable used for wheat from August 22, 2007 to September 20, 2007,
SDJ_MR08: Slope dummy variable used for wheat from January 24, 2008 to March 31, 2008,
DEXRSTR: Intercept dummy variable used to include wheat export restrictions by some countries in the period from February 16 to 18, 2008, and March 11 to 13, 2008,
SDSBNSQ: Slope dummy variable for new crop of soybeans from December 3, 2007 to March 10, 2008.

in order to represent smaller new crop harvest esti-mates taking place in the southerm hemisphere from December 3, 2007 to March 10, 2008.

Results of the statistical analyses are shown in the Table 1. The estimated coefficients are all at 1% signifi-cance level with the right sign which means the positive relationships between grain and oil prices. These results indicate that prices of rice, corn, wheat and soybeans increase by US$0.180/cwt, US$0.0515/bu, US$0.0441/ bu and US$0.101/bu, respectively, when oil prices go up by US$1/barrel. However, the magnitudes of change in prices of individual grains appearred to be different. Results indicate that corn and soybeans prices are more sensitive to oil prices as compared with rice and wheat.

Rising prices of oil had direct upwards pressures on grain prices in the global markets since fertilizer prices and transportation costs increased accordingly with oil prices. Fertilizers, as intermediate input to the produc-tion process, account for 30%–40%[2] of total cost of production of agricultural crops. Prices for diammonium phosphate (DAP), Phosphate rock, Potassium chloride, triple superphosphate (TSP), and Urea were 213% higher by July 2008 over the prior period a year earlier; the biggest gainer was Phosphate rock which has risen 359% between July 2008 and July 2007[3]. Prices of the three common nutritional elements in fertilizers that are nitrogen, phosphorus, and potassium (N-P-K) have gone up by 77.82% from January to July 2008[4]. Natural gas accounts for 70–90% of total production costs of ammonia that is material for nitrogen (Agriculture and Agri-Food Canada, March 2007).

In response to rising prices of oil, grain crops are being increasingly used as feedstock for bio-fuel pro-duction. Currently, corn and soybeans are processed to convert into bio-fuels in the U.S., China, Japan, and biodiesel in Europe. This trend has been driving prices of corn and soybeans upwards and becoming more directly related to oil prices. In 2007, the total produc-tion output of ethanol in the U.S. was 7 billion gallons, the greater demand may increase output to 13 billion gallons soon, which is equivalent to one-third of the U.S. corn produced to be converted to bio-fuel. Currently, in the U.S., corn and soybeans are grown in essentially

the same ground (Wallace E. Tyner, Purdue University). As a result, rising demand of corn for ethanol means there is less space available for soybeans to be planted. This tendency makes prices of soybeans become more volatile in the coming years. Furthermore, grains are substitutes with one another to some extent in the global markets, thus rice and wheat prices are becom-ing more and more influenced by oil prices.

"Fund money flowing to agriculture has boosted prices. It's fashionable. This is the year of agricultural commodities," said Abah Ofon—food commodities ana-lyst, Standard Chartered Bank. Soaring of oil prices was a strong reason for investors flocking to specula-tion of food commodities that, they thought, might have less risk than in oil business. This situation strongly attributed to the recent sky-high prices of food crops.

## 5. Conclusion

There is a general tendency that prices of major food crops fluctuate together in a sort of harmony. This is because food grains are substitutes with one another. The magnitude of fluctuation varies depending upon crops, but a uniformed trend of price movements for all crops does exist. Changes in climate as a result of global warming and changes in policies by individual countries are becoming key factors for increasing the price volatility of global grain crops.

Unforeseeable increases in oil prices strongly drove upwards prices of fertilizers and transportation costs. In addition, the competition of demand between food and bio-fuels for grains has been stronger over time. Prices of food grains and oil are becoming more cohesive. Soaring prices of oil have remained one of the core attributes to the skyrocketing prices of grain crops in 2007 and 2008. To keep the relatively higher prices for wheat and rice, their use for bio-fuel produc-tion may be important.

For a further research, the D.W. statistics in the results indicate a serious correlation in the error term. Although the current results would not be changed much in the basic structure, other procedures to correct the correlation should be explored. Also, the grain prices have change drastically after August 2008;

therefore, a new analysis should expand study period.

## Notes

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