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Carry or not Carry? When the Commodity Market is under Stress

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Abstract

This article presents two statistics based on the future prices of commodities. The first statistic discussed represents the carry level and should account for the convenience of the storage of a physical commodity. The second statistic discussed represents the risk perception in the pricing of a future contract. Both statistics are presented in the two first sections. The third section presents the numerical results with the interpretation of some events reported by the monitors built on our two statistics. See also the disclaimer at the end of the document.

Keywords: commodities, carry, convenience yield, risk perception, market stress.

Introduction

The commodity market is an heterogeneous investment universe. Beyond the classical CTAs which mainly invest in the future market, there is a huge physical market as well as a growing number of investment opportunities in companies active in the commodity sector. Investing in such companies or in traders who are active on the physical market can be done through a direct participation (equities), debt or all the intermediate products. Commodities are tightly related to emerging markets or developing economies. Indeed, most of the commodity reserves are located in emerging or developing countries. Finally, because of their levels of indebtedness and the recent poor growth perspectives, developed countries are these days much less attractive for investors. As a result, more and more people are focused on emerging markets and the commodity sector.

In this document, we are interested in the development of statistics which calculation can be easily automated and which provides early signs of stress on a given commodity. To automate the calculation of these statistics, we must rely on standardized data feeds, like those provided by the future markets. The early signs of stress can then be used as triggers in an activist investment approach to request a more detailed analysis of the situation resulting in a quick anticipation of risks and allowing efficient hedge or mitigation.

We first present the theoretical foundation which our indicators, namely the carry level and the market risk perception, are based on. A detailed explanation of the underlying theory can be found in Hull (2009). Then, we analyse a set of commodities and compare the periods of stress reported by our statistics with the history of the commodity. We also provide some typical behaviour, often related to the type of the commodity.

All data used in this document is provided by Bloomberg.

1 The Future Curve

Suppose that the actual storage cost (price multiplier) of a commodity is e^{uT}, where u is the actualised cost rate and T is the time to expiry. The rate u can be derived from the spot prices obtained on a physical market and the storage prices invoiced by the warehouses. Suppose also that the future price F_0 is such that

$$F_0 e^{-r_T} > S_0 e^{uT},$$

where e^{r_T} is the value at time T of one unit of capital hold on a risk-free account. One procedure that a trader can follow is: borrow a quantity $S_0 e^{uT}$ of capital, purchase the commodity, pay for the storage upfront and enter in a future short position to sell the commodity at time T. If all the above assumptions are satisfied, his final cash flow is

$$F_0 - S_0 e^{uT+r_T} > 0.$$

Because there is a possible risk free profit, the trader will enter in the procedure with the highest quantity he can get on the market, putting pressure on the prices until

$$F_0 \leqslant S_0 e^{uT+r_T}, \tag{1}$$

which is a relation that must hold in a world where arbitrage opportunities do not exist.

On the other side, it is not possible to own negative quantities of physical commodities. Thus, only companies which own the commodities can sell it and repurchase it at a later date if the inequality in equation (1) is strict. Usually, companies which store commodities do this because of a real industrial need. Thus, this is not rare to see a strict inequality in equation (1). The difference often comes from other industrial opportunities and is often modelled through a convenience yield y by the relation

$$F_0 = S_0 e^{(u-y)T+r_T}. \tag{2}$$

Typically, the convenience yield $y = 0$ for purely investment assets such as gold, which is easily available for industrial purposes.

Denote $z = u - y$. This variable z can be high for two reasons: high storage cost and low convenience yield. The variable z is low for opposite reasons. Thus, the level of z can be an interesting monitoring statics. In Section 3, we give our estimates of the variable z with some interpretations of the level of

z at different periods. Further in the text, we call the variable z the carry level. Indeed, the higher z, the less convenient it is to store the commodity. Note that we do not need to estimate separately u and y.

2 Future Price vs. Expected Spot Price

Another interesting point in the theory of futures is the relation between the future price F_0 and the expectation of the spot price at the expiry date of the contract $\mathrm{E}(S_T)$. Indeed, entering the position at a future date T can be done in two different ways:

1. by buying the assets at time T. The spot price S_T paid this way is uncertain now (at time 0).

2. by buying now a future contract forcing us to purchase the asset at time T and at a fixed price F_0.

Both strategies should have equivalent actual values. Thus,

$$F_0 e^{-r_T} = \mathrm{E}(S_T) e^{-kT}, \tag{3}$$

where k is an actualisation factor which should take into account the risk in the price S_T. If we make a simple assumption that the commodity prices follow a log-normal distribution, we can calculate the expected spot price at expiry from the value of the spot price now and from estimates of the rates of return and volatility. We have

$$\mathrm{E}(S_T) = S_0 e^{\mu T + \frac{1}{2}\sigma^2 T}. \tag{4}$$

From equations (3) and (4), we obtain

$$F_0 = S_0 e^{(\mu + \frac{1}{2}\sigma^2 - k)T + r_T}. \tag{5}$$

Let's denote $\theta = k - (\mu + \frac{1}{2}\sigma^2)$. Both k and θ can be derived for each future price given a path for the spot price. This spot price path can be estimated from equation (2) and the paths of all the available contracts on a given commodity. Note that from equations (2) and (5), we should have

$$z + \theta = 0.$$

Thus, by observing the spread between both figures, we can build signals showing situations of stress on the commodity prices. The variable θ can be seen as a spread between the assumption that the market is arbitrage free and the commodity prices behave the same way than in their recent past. This is indeed the difference between the real discount factor applied to the future price and the discount factor resulting from the above assumptions[1].

3 Results and Interpretations

In this section, we present the results based on the daily closing prices of futures from January 1, 2002 to August 12, 2010. We organized the discussion by commodity type. This natural organization appeared to be convenient. Indeed, the behaviour of our indicators appeared to be different between the commodity types and often similar within (especially within the agricultural commodities). In each section, we first present the results for the carry level and then for the level of perceived risk.

The risk perception statistic is available for each open contract. The the following results, we present a weighted average in order to have a single indicator[2].

[1] Note that the assumption on the returns behaviour (growth rate and standard deviation) are strong and the method used to generate the results in this document is simple. Thus, the final estimates of θ can exhibit a significant bias.

[2] The most liquid contracts are the most dominant

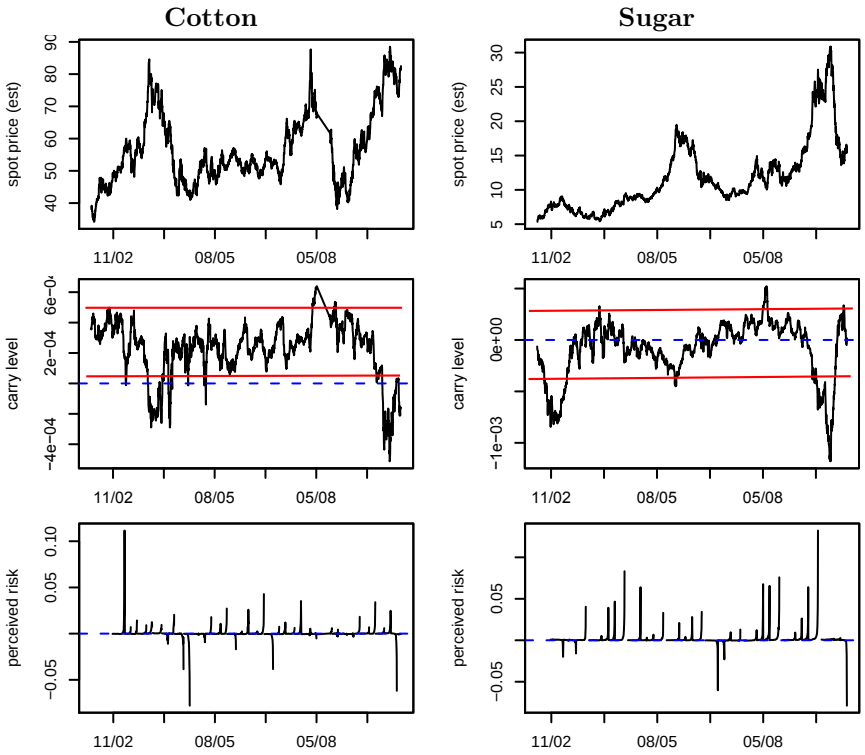

Figure 1: Cotton (left) and sugar (right) statistics. The first row shows the estimates of the spot prices. The second row shows the carry levels. The third row shows the risk perception level. The red tunnel shows what looks like a "normal" evolution range. Exits out of this range (which mostly occurs on the lower side) indicates stress on the commodity.

3.1 Soft Commodities

Figures 1 to 4 show the results for cotton, sugar, soy bean meal, soy bean oil, cocoa, coffee, rough rice and frozen orange juice. Each figure shows the estimated spot price, the path of the carry level z and a time weighted average of the risk perception θ. The soft market has two particularities: the carry level z is stable around zero or slightly above, with negative peaks around some specific crops. During these peaks, it seems that the convenience yield soars. In the case of agricultural commodities, such phenomena is often explained by diseases, poor climactic conditions or any event which implies a small crop yield putting pressure on the markets. Recent fires in Russia are such events.

In November 2003 and March 2010, the cotton prices soared, what coincided with a low carry level. On the other hand, early 2008, the cotton prices soared and no indication of any market stress was given by our statistics. Similar comments can be done on the sugar. From October 2002 to February 2003 and from December 2009 to February 2010, the carry level was at low levels and there was simultaneously a stress on the sugar market which was corrected when the level z reached levels around zero. As in the cotton case, end of December, there was a peak in the sugar price which was hardly reported by the level of z.

One interesting commodity is coffee. Indeed, end 2004, there seems to be a down shift in the equilibrium level. This shift indicates that there was a sustained increase in the convenience yield. This shift appeared simultaneously with a disease on the coffee plants in Brazil.

The perceived risk statistic θ seems rather flat around zero. We can notice peaks which comes from behaviour at expiry. Most of the time, peaks are positive[3]. This indicates a stress on the investors with the long positions. This stress can be explained by the amount of investors with long positions who must roll their portfolio. Long only fund like index trackers are typically such investors. More equilibrated situation are also possible, the cocoa market is a good example.

[3]Soy bean oil is a good example.

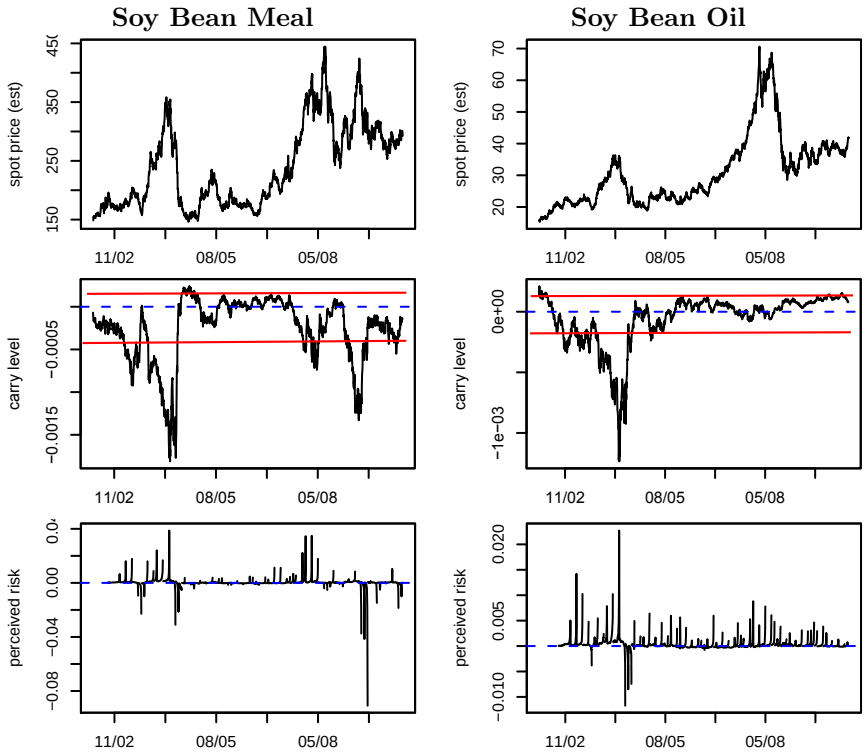

Figure 2: Soy bean meal (left) and soy bean oil (right) statistics. The first row shows the estimates of the spot prices. The second row shows the carry levels. The third row shows the risk perception level. The red tunnel shows what looks like a "normal" evolution range. Exits out of this range (which mostly occurs on the lower side) indicates stress on the commodity.

3.2 Grains

Grains are closely linked to soft commodities and thus, the main comments are similar. Figures 5 and 6 show the estimated spot prices, the carry levels z and the risk perception θ for corn, oat, wheat and soy bean.

From September to December 2002 and from August to December 2007, the carry level indicated a stress on the on wheat. Similar things happened for soy beans in May 2003, from February to July 2004 and from May to June 2009. Note that the stress were always in the same direction: an increase in the convenience yield. Two phenomena can explain such behaviour: bad news on the crop yield (due to weather conditions or disease) or speculation on a price increase creating a bubble. The latter often arrived in the last decade when speculators became over optimistic on Chinese or Indian consumption initiating the bubble. Then, the speculation itself drives the size of the bubble. Speculative bubbles can be identified when commodities of different nature are simultaneously impacted. An example is the 2008 price growth.

The risk perception statistic shows differences in the behaviour near the contracts expiry. The discount seems to be greater for wheat than for soy beans.

3.3 Energy

The energy market exhibits patterns which are slightly different from the patterns found in the agricultural commodities. Figures 7 and 8 show the spot prices, the carry level z and the perceived risk θ for the WTI crude oil, the heating oil and the natural gas contracts.

When the oil prices started to fall in July 2008, the carry level started to soar indicating that many investors were uncomfortable with their physical or short term long exposure. When the situation stabilized, the carry level remained slightly above the levels recorded between 2002 and July 2008. The perceived risk gives us valuable information. Before 2005, θ was systematically below zero. This

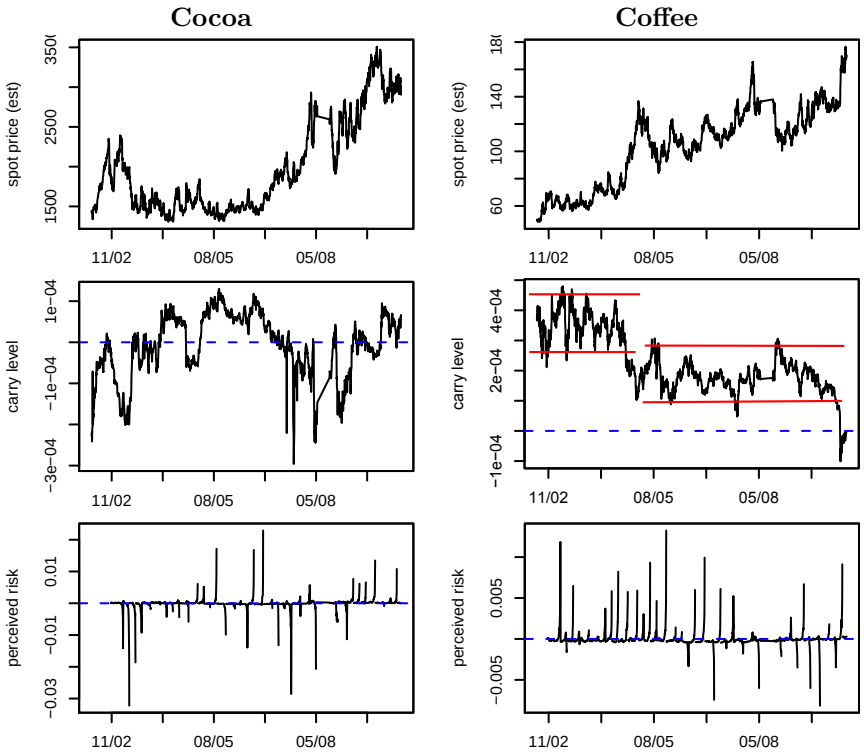

Figure 3: Cocoa (left) and coffee (right) statistics. The first row shows the estimates of the spot prices. The second row shows the carry levels. The third row shows the risk perception level. The red tunnel indicates what seems to be a "natural" range for the commodity. At the end 2004, coffee exhibits a down shift, indicating an increase of the convenience yield.

pattern is rare and hardly seen in other commodities. A negative θ implies that the investors are risk takers. We see at that time a rapid price growth. From 2005 to early 2008, the pattern reverted. The risk perception became positive. As a result, the prices continued to grow, but at a slower rate and in a more volatile fashion. Early 2008, motivated by a sustained price growth, the risk perception became one more time negative and we saw the prices climbing until May 2008. Then, the oil price was well above USD 110. The risk perception started to soar, what indicates a panic on the market. The result was a deep and rapid fall since July 2008. After that, the risk perception remained positive, what seems to be a much reasonable attitude.

Heating oil exhibits features which can be explained by recent development in the energy market and ecological behaviour. The first thing that we can notice is the similarities between the spot price of heating oil with crude oil. Beyond this natural link, we see that the carry statistic follows a global up trend. This indicates that there is less and less interest in the commodity. A possible explanation is the recent trend to renewable sources of energy for heating purposes in developed countries. The risk perception factor exhibits a stable path with clear yearly cycles.

The gas prices follow a path which is similar to crude oil prices, except during periods of stress such as the winter 2005–2006. This stress was resulting from the conjunction of three distinct events: Katrina, then Rita (Roesser 2009), both followed by a severe winter. The path of the carry is strictly the same than the path of the crude's carry level. We notice only a divergence during the winter 2005–2006, where the carry level of the natural gas shows a higher convenience yield. The risk perception exhibits the same cycles than heating oil, but shifted in time. The logistics of the delivery process can explain this shift. Indeed, gas delivery is immediate, while heating oil delivery must be scheduled. Moreover, heating oil can be stored in houses, while gas is directly provided by pipes. The risk perception just following the winter 2005–2006 soared implying a strongly expected price correction.

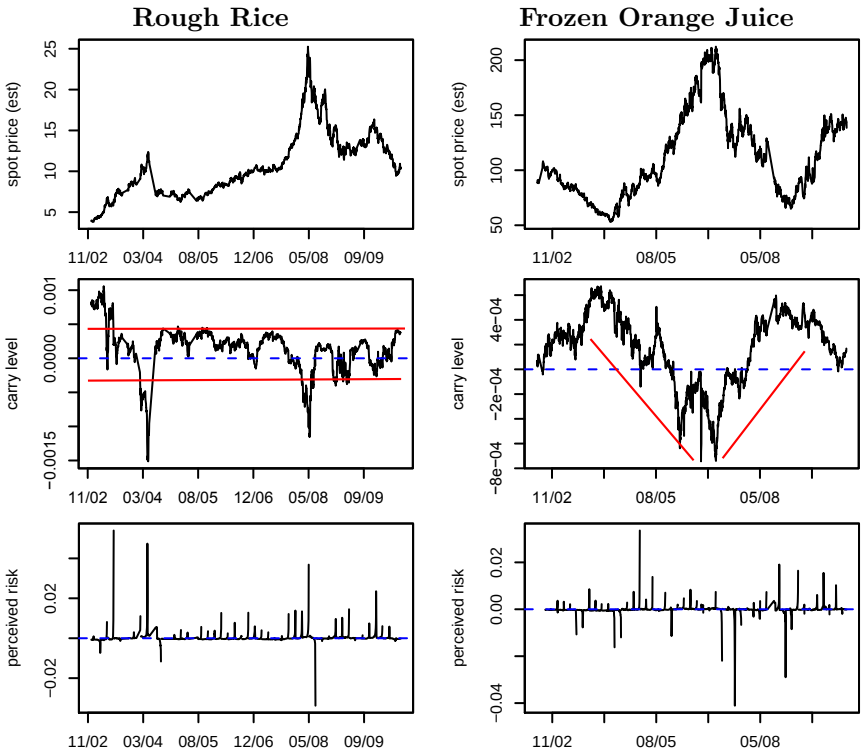

Figure 4: Rough rice (left) and frozen orange juice (right) statistics. The first row shows the estimates of the spot prices. The second row shows the carry levels. The third row shows the risk perception level. The red tunnel on the rough rice carry level graph has the same pattern interpretation than the red tunnels on cotton, sugar, soy bean meal or soy bean oil. The red lines on the orange juice graph emphasize the down-trend up to 2008 followed by the up-trend on the carry level.

3.4 Metals

The metals market has a lot of singular properties. First, metals have a wide range of usages. They can be used in the industry for building ships, skyscrapers, cars, toys or electrical devices and can even appear in the composition of drugs or cosmetics. They can be stored for long periods of time and thus some of them are used as pure investment or speculation assets. The Figures 8 and 9 shows the estimated spot price, the carry level and the risk perception for Gold, Silver and Copper.

The first thing which is striking is the price evolution for the last seven years. The price of each metal in our sample has been multiplied by a factor between 3 and 4. The most impressive path is the path of the gold price, which exhibits a steady growth slightly above 20% per year[4]. The stability of gold prices is confirmed by the stability of carry level, which deflected from its near zero path only during the sub-prime crisis indicating a rush towards gold. Even if the risk perception graph seems to indicate some structure, it is at a much smaller scale than the other commodities. This is an indication that even the price discrepancies during the rolling periods are of much smaller amplitude.

Silver and Copper, which are linked more strongly to the industry, exhibits a much different path. First, they are much more volatile than gold, which is more common for commodities. When the markets plummeted in 2008, silver and copper followed the same path, thought with a recovery which was much faster than the stock market. The V-shape of their carry level suggests a particular behaviour from speculators. The down trend up to 2005, the following up trend up to the sub-prime crisis and the stabilisation at original levels indicate that speculators were accumulating long positions up to 2005 and then took the opposite direction afterwards. Those two behaviours can be explained by the perception of China's growth which was huge before 2005, but not confirmed by import/export statistics. This growth in interest for industrial metals went together with an increase of the risk perception.

[4] An investor should deduct the storage cost.

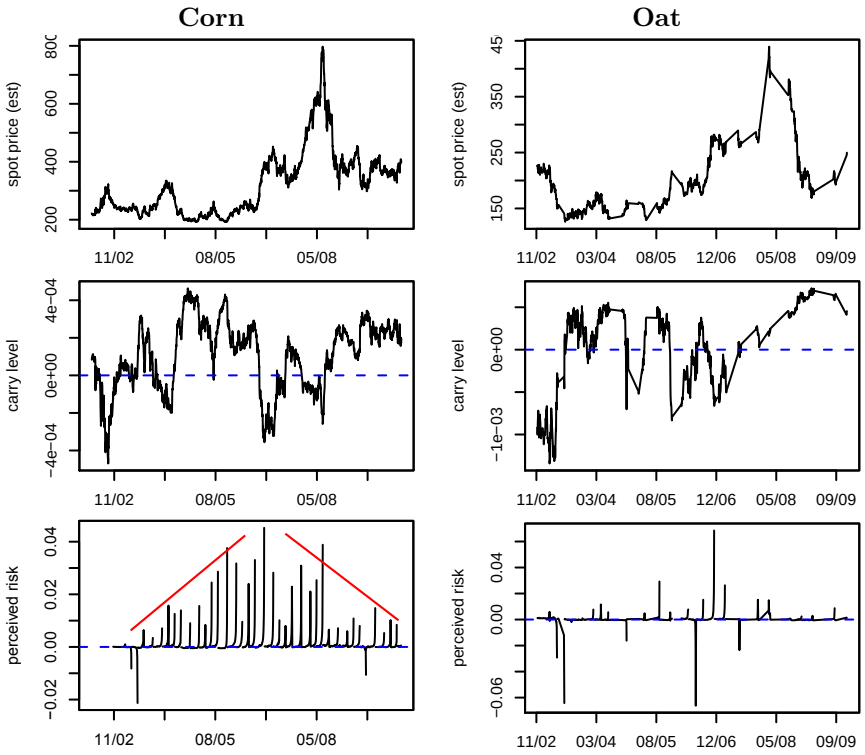

Figure 5: Corn (left) and oat (right) statistics. The first row shows the estimates of the spot prices. The second row shows the carry levels. The third row shows the risk perception level. The red lines on the corn perceived risk graph emphasize the trends near contract expiries.

3.5 Livestock

Livestock is the last group of commodities in our study. It is a group in itself, as the behaviour of the prices seems to exhibit group properties, while being different from other commodities. Figure 10 shows the estimated spot prices, the carry level z and the perceived risk θ for Lean Hog and Live Cattle.

First, we see that meat price slightly increased during the last seven years (this up trend can be better seen on live cattle). But the most striking property of livestock is certainly the cycles in both the carry level and the risk perception. This can be explained by the barbecues, which are extremely popular in the United States when the weather is nice, which is especially the case in summer.

Discussion

Throughout the document, we have shown how to build some stress indicators and have given their interpretation. Moreover, we have shown that they report efficiently some situations of stress. We have discovered that agricultural commodities often exhibit the same pattern. They move in a range and exit this range from bellow typically when there is a problem with the supply or the production. We have emphasized the stability of gold, as well as the cycles in the commodities which have a relation to the seasons. Examples are heating purposes commodities like heating oil and natural gas or barbecue commodities like live cattle or lean hog. Another interesting feature is the decrease in the the convenience yield of heating oil.

Further developments are possible. For example, we can determine whether there exists a typical level of stress which can be generalized to all instruments. A beginning of an answer is provided by crude oil, which exhibits a shift in the equilibrium level following the 2008 crisis. Only future will determine if it is a new equilibrium level, a transition phase or a long lasting stress period ready to be corrected in one side or another.

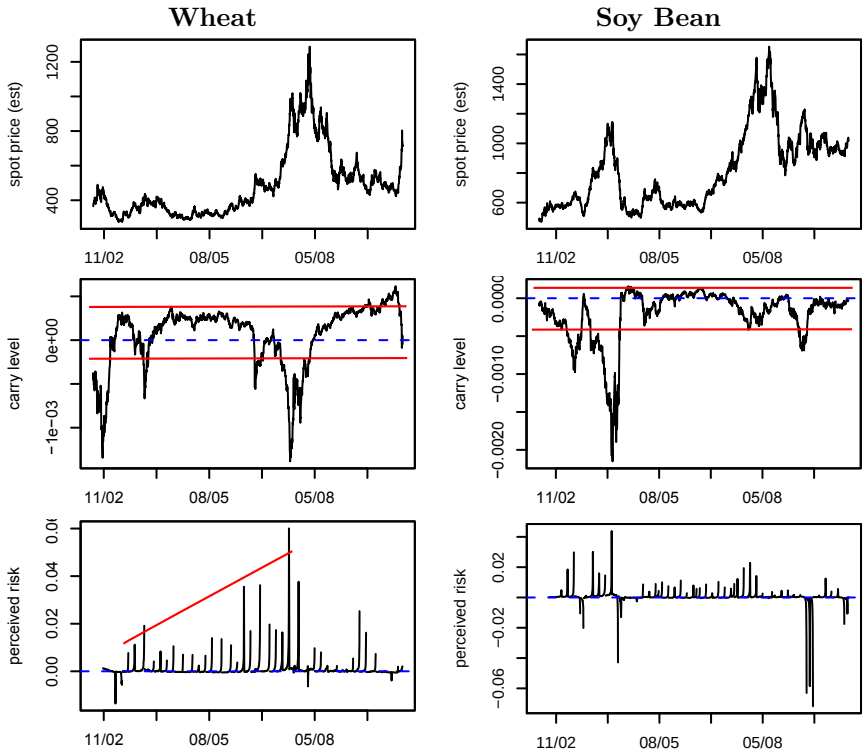

Figure 6: Wheat (left) and soy bean (right) statistics. The first row shows the estimates of the spot prices. The second row shows the carry levels. The third row shows the risk perception level. The red tunnels on the carry show the "normal" evolution range. The red line on the wheat perceived risk graph emphasizes the up-trend seen up to 2008.

Disclaimer

This article presents statistics which can be used to determine whether there is a stress on a given commodity market. This article contains simplified versions of these statistics, presented as such for an illustrative purpose. The accuracy of data and figures provided in this document is given without guarantee. The aim of the statistics is to trigger additional analysis on a given market. These are not the only possible triggers and there are certainly situations of stress not reported by these statistics. Moreover, if you base your investment decisions on the content of this document you understand that you do this at your own risk and that INOKS Capital SA and the authors of this document decline any responsibility whatever the outcome of these investment decisions is.

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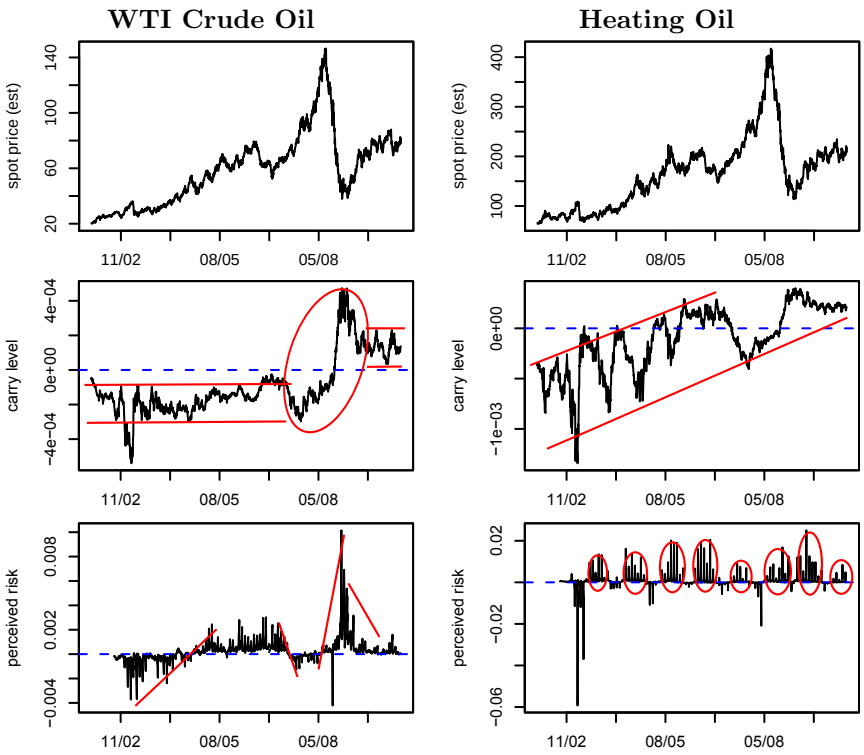

Figure 7: WTI crude oil (left) and heating oil (right) statistics. The first row shows the estimates of the spot prices. The second row shows the carry levels. The third row shows the risk perception level. The red tunnels indicating the evolution range of the carry level for crude oil and heating oil exhibit distinct patterns. Crude exhibits a first stable range up to 2008, a stress due to an over-supply and then a stabilization at a slightly higher level indicating less convenience in storing crude oil. Heating oil has a range with an increasing pattern, showing a decrease in the convenience for this commodity. The lines on the perceived risk statistic shown that the crude oil market mood is often changing, while the red circles on the heating oil perceived risk graph emphasize cycles.

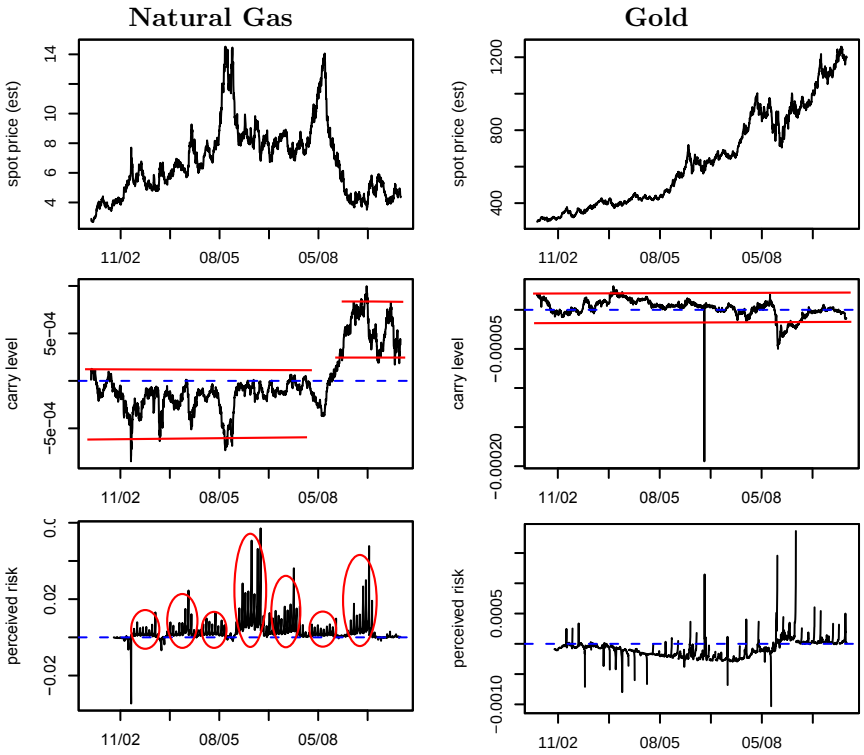

Figure 8: Gas (left) and gold (right) statistics. The first row shows the estimates of the spot prices. The second row shows the carry levels. The third row shows the risk perception level. The red lines and circles on the natural gas graphs indicates that natural gas has the same convenience yield than crude oil and similar (time shifted) cycles to heating oil cycles. Gold red tunnel shows stability.

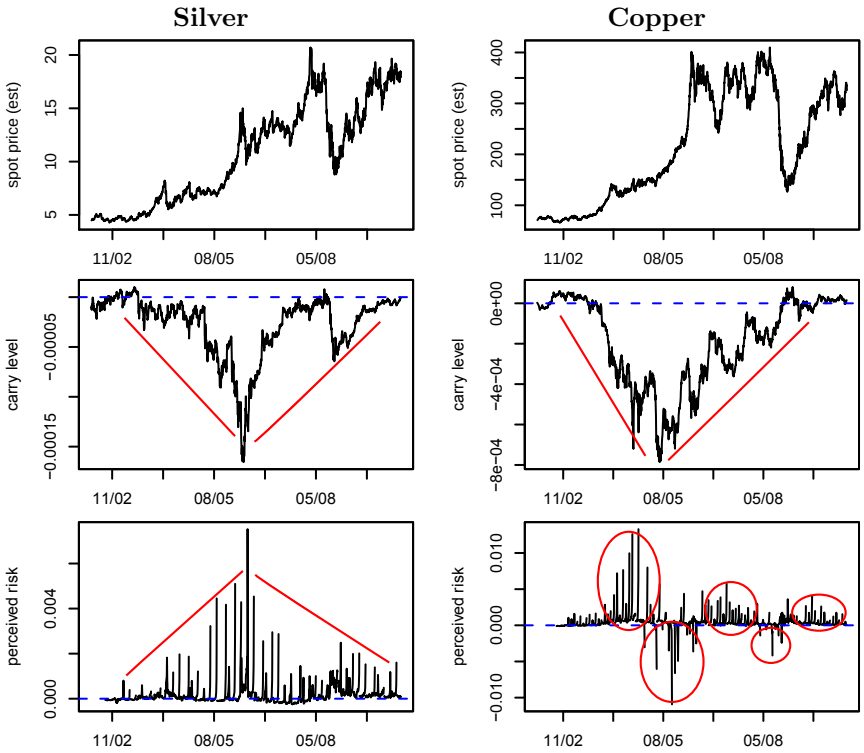

Figure 9: Silver (left) and copper (right) statistics. The first row shows the estimates of the spot prices. The second row shows the carry levels. The third row shows the risk perception level. The red lines on the silver and copper carry level graphs exhibit a V-shaped pattern. Red drawings on the perceived risk are different. Silver exhibits an inverted V-shape while copper exhibits clusters of positive and negative perceived risk.

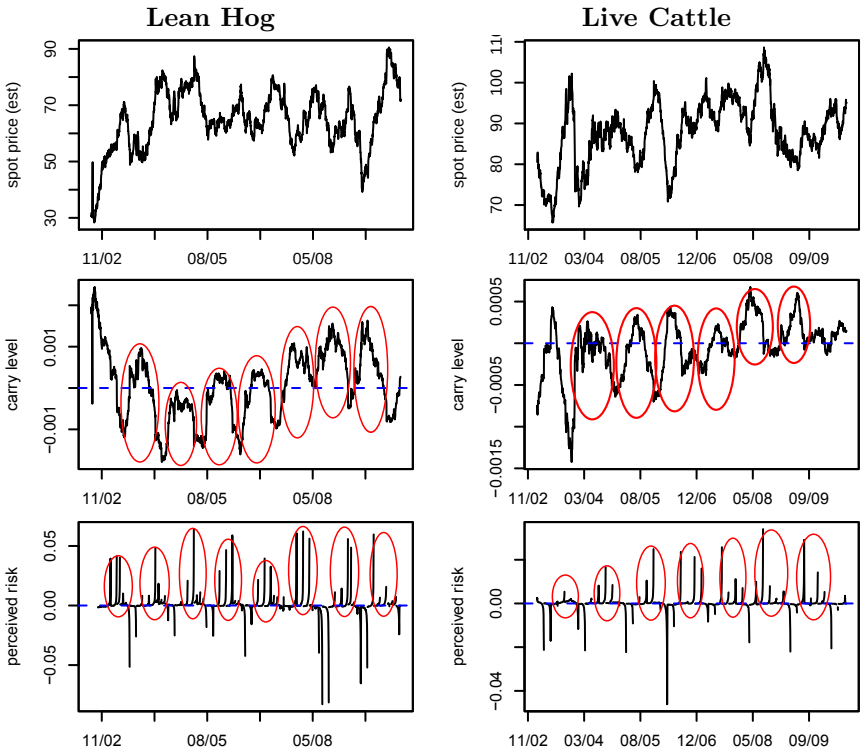

Figure 10: Lean hog (left) and live cattle (right) statistics. The first row shows the estimates of the spot prices. The second row shows the carry levels. The third row shows the risk perception level. The red patterns on livestocks exhibit clear cycles. These cycles can be seen on both the carry level and the perceived risk.