TAIL WAGGING THE DOG: IS CHINA’S MTO THE DRIVING FORCE BEHIND METHANOL PRICING?

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Over the last five years, the use of methanol in China has undergone a radical shift. From being a traditional feedstock in industries such as formaldehyde and acetic acid, methanol is now the cornerstone of petrochemical innovation — methanol-to-olefins technology — which converts it to higher margin polyolefins.

Anecdotal evidence already suggests that Asian methanol prices are strongly influenced by the growing downstream segment — Chinese methanol-to-olefins plants, and price plots of methanol versus polyolefins show a high degree of correlation in recent years after MTO plants were built, but not before (see charts: CHINA METHANOL VS CHINA PP AND PE).

Good margins compared with other methanol end-users may have catapulted MTO plants to the status of swing buyer in recent years, and future MTO capacity increase is likely to cement that status.

This special report provides an insight into the drivers behind Asian methanol prices and the general approach is potentially useful for analyzing other inter-commodity relationships.

Stats show methanol price now hitched to PP price as MTOs become prevalent
A new S&P Global Platts statistical analysis shows that changes in polypropylene prices in China can be used to help understand changes in methanol prices in a statistically significant manner, with evidence from industry sources pointing to Chinese MTO plants as the mechanism.

Taking the example of the relationship between methanol and PP, a 1% change in the week-on-week increase or decrease of PP raffia CFR FE Asia average weekly price will, on average, result in a 0.68% change in the week-on-week increase or decrease of the methanol CFR China weekly average price, according to statistical analysis conducted by S&P Global economist Vincent Conti.

This relationship is apparent only after 2014 — when the MTO segment took off in a big way — and only when the PP price is above the $980/mt threshold.

These changes, technically termed acceleration or deceleration, can be explained by taking the example of PP prices rising 2% last week and 3% this week — its week-on-week acceleration would be plus 1%. The regression model would predict this week’s methanol prices to be last week’s plus 0.68% on average. So if methanol price grew 1% last week, then the model would predict a 1.68% rise this week, after considering PP price acceleration.

Conversely, a deceleration of PP price is predicted to curtail methanol price growth.

The model was able to explain three key market observations. First, the relationship between methanol and polyolefins is likely caused by MTO units using methanol as a feedstock to produce polyolefins, so there should be no relationship between the two before MTOs existed. This was in fact found to be the case: pre-MTO PP prices (October 2011 to December 2012) had no significant influence on methanol prices.

Secondly, industry sources said MTO plants do not buy feedstock on a daily basis in reaction to daily PP price swings. In fact, initial analysis looking for a daily price change relationship failed to detect any, whereas a relationship was only found after looking at weekly price changes.

Third, when PP prices fall below the profitability range for a typical MTO unit over an extended period of time, MTO plants should logically cut back on their methanol purchases, reducing the degree to which PP prices influence methanol prices. In fact, the analysis found that when PP raffia prices fall below the threshold of $980/mt, its influence on methanol prices wanes — offering a tantalizing possibility that the breakeven level for the average MTO unit may be detected using statistical tools.
The chart shows the model’s predicted methanol prices alongside actual prices during periods when PP prices exceed the $980/mt threshold (see chart: METHANOL PRICE MODEL VS ACTUAL CFR CHINA WEEKLY AVERAGE PRICE). A technical discussion of this model, technically an ordinary least squares regression, is detailed in the Statistics Appendix.

We will now look at some of the market factors which underpin this model.

Causality: Does a change in polyolefin price cause a change in methanol price?

To have a predictive model, the direction of the causality has to be determined: Does a change in the polyolefin price cause a change in the methanol price or is the reverse true?

“From what we observe [in] the market, polyolefin prices tend to cause methanol price movements, not the other way around, since the PP and PE markets are large and come from a variety of [feedstock] sources,” a trader said in August.

Although Chinese MTO capacity is growing quickly, it represents a small proportion of overall capacity and competes at a disadvantage compared with Chinese coal-to-olefins plants, which have their own integrated methanol feedstock, as well as naphtha-based steam crackers, which have benefitted from cheap naphtha feedstock since the 2014 fall in crude prices, sources said.

Typically located in western China, CTO plants use coal as a feedstock to produce their own methanol to feed their integrated MTO units, and are usually integrated all the way down to polyolefin plants. Coastal MTO plants on the other hand, need international imports.

S&P Global Platts Petrochemical Analytics estimate that the total cost of production per ton of olefin in July 2016 was about $937/mt for a MTO unit in East China, $568/mt for a CTO plant in Inner Mongolia, and only about $407/mt for a naphtha-based steam cracker in East China.

For the methanol suppliers however, the MTO segment is a rare bright spot in an otherwise gloomy methanol landscape.

“MTO [plants] can accept higher prices for methanol, unlike [the] acetic acid and formaldehyde markets,” a major methanol distributor said. Formaldehyde is used for producing thermoset resins linked to the construction industry, which is currently in a slump in China, traders said.

This means MTO plants often act as the swing buyer of methanol, purchasing cargoes at a price that deters other buyers, a trader said. Good polyolefin prices translate to good MTO margins and higher procurement of feedstock methanol. However, the reverse is also true, added the source.

In other words, a change in methanol prices alone is unlikely to cause a change in polyolefin prices, while evidence points to a change in polyolefin prices causing a change in methanol prices.

GLOBAL METHANOL DEMAND BY END-USE, 2015 (%)

CHINA MTO/MTP OLEFIN PRODUCTION FORECAST AND IMPLIED METHANOL DEMAND

MTO capacity set to grow, cementing its status as the swing buyer of methanol

Industry sources have also offered anecdotal evidence suggesting that China’s MTO plants are the swing buyers, despite accounting for only a fraction of the demand.

Methanol demand for MTO olefin production expanded to 11% of the total global demand of 80.5 million mt in 2016, up from 9% in 2015, according to Nexant.

Going forward, MTO plants will continue to be the swing buyer if two key factors are met: healthy MTO capacity growth to underpin methanol demand, and firm downstream polyolefin prices.

“According to our forecasts, we are seeing methanol demand from the MTO/MTP [segment] growing by almost 10% a year from 2015 to 2025,” Manuel Asali, vice president of Nexant said in August.

China’s MTO production is expected to grow 1 million mt year on year to just short of 7 million mt in 2017, according to Platts Petrochemical Analytics. The implied methanol demand from full operating rates will be 19 million mt in 2017, requiring more methanol imports.

“When PP prices rise past a MTO plant’s breakeven, they [MTO plants] will secure the [feedstock] methanol cargoes required and ramp up operational rates,” a source from Zhejiang Kinlead Innovative Materials Company said. Zhejiang Kinlead is a major Chinese BOPP end-user.
MTO 2016 margins healthy but volatile
China’s MTO units have been largely profitable in 2016, with margins surging 162% year on year in July to $136/mt, according to Platts data.

“MTO [plants] have been operating at a high rate in the first half of 2016,” a methanol distributor said, and Q2 restocking activity by MTO units has been so active that storage space is “becoming an issue,” he added.

The exception occurred during November 2015 to January 2016, when PP raffia prices fell below the $900/mt level for so long that MTO margins dipped below breakeven for almost four months, underscoring its dependence on volatile polyolefin prices.

According to Platts data, CFR FE Asia PP raffia prices fell $20/mt day on day to $880/mt on November 11, 2015, and would stay below the $900/mt level until March 7, 2016. Traders attributed the fall in prices to weak demand amid China’s economic uncertainties early this year.

MTO’s conversion cost from methanol to polypropylene compares the variable cost of 3 mt of imported methanol (CFR China) plus $200/mt of fixed cost against the cost of PP raffia (CFR FE Asia). Chinese industry sources said an MTO plant typically consumes 2.8-3.0 mt of methanol per ton of olefin produced and has a feedstock to polyolefin fixed cost range of about $195-$225/mt.

However, positive margins in the MTO segment from March to August have fueled an extraordinary rebound in the fortunes of MTO plants — and a corresponding influx of methanol imports, industry sources said.

Imports from the US and Latin America to fuel China future MTO demand
China’s Q2 methanol imports surged 89% to almost 2.6 million mt compared with same quarter last year, according to Chinese customs data. Of these imports, 21% came from three new sources: Trinidad & Tobago, Venezuela, and the US, up from practically no volumes in 2015.

The shift in the movement of methanol cargoes from the Americas to China is in part, due to China’s growing MTO demand, but more importantly, due to the dramatic expansion of US shale gas-linked methanol production.

US methanol production capacity expanded 156% year on year to 5.75 million mt/year in January 2016, and is poised to expand further in 2017 with the expected startup of the 1.75 million mt/year Natgasoline in the US Gulf Coast, and the 1.92 million mt/year South Louisiana Methanol, according to industry sources.

These additions will see the US flip fully from a net methanol importer to a net exporter, which in turn will force Latin American producers — the traditional suppliers to the US — to look towards Asia in the future.

If China’s MTO capacity continues to expand as expected, it will increasingly rely on methanol from the Americas, and in particular the US, as one of the last untapped source of methanol production growth. This will in turn cement the methanol trade flow from the Americas to China in the long term.

MTO/CTO capacity surge pushes polyolefin market towards supply overhang in H2
Let us now look at the short term outlook for MTO, and how this will impact demand for methanol.

MTO margins in 2016 will be tied to the outlook for polyolefin in the second half of the year, sources said.

Asia’s PP prices had been supported by summer turnarounds and curbs in production at Chinese plants prior to the G20 summit in Hangzhou early September, but is expected to weaken in mid-Q3 and Q4 as startups outpace demand, industry sources said. The PE market is likely to follow a similar arc, with a relatively firm Q3 but a weakening Q4 as supply lengthens.

Shanghai Environmental Protection Bureau has ordered plants to reduce operational rates or even shut down ahead of the G20 summit. Affected plants include: Shanghai Petrochemical’s two lines with a total capacity of 200,000 mt/year, Sinopec’s 60,000 mt/year PP plant, and Tianjin United’s 60,000 mt/year plant. Sinopec Zhenhai Refining and Chemical’s 450,000 mt/year linear low density polyethylene plant is likely to reduce its operation rate under the G20-related directive.

But in Q4, polyolefin startups will begin to weigh on the market. The majority of China’s 3 million mt/year of new CTO/MTO capacity addition in 2016 is scheduled for a Q4 start, industry sources said.
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On the MTO front, Fund Energy's 300,000 mt/year polyolefin plant at Changzhou will be delayed from mid-year to Q4 2016, sources said.

Shenhua Group's 600,000 mt/year PP expansion at its Ningdong CTO plant will be completed in October, an end-user said, which will increase domestic supply in Q4 and fuel export pressure for PP homopolymers.

On the PE front, China is still the world's largest importer, but the deficit is expected to narrow to 9.2 million mt by the end of 2016 due to the new startups, from 9.8 million mt in 2015, according to Platts Petrochemical Analytics.

Meanwhile, global PE capacity will increase by 7 million mt/year in 2016. This will come predominantly from CTO and MTO plants in China, but Russia, Central Asia, India and Iran are also adding capacity, which may result in a price war for market share in Q4, depressing Asian PE prices, traders said.

With polyolefin competition expected to heat up due to lengthening supply late 2016, healthy MTO margins may be at risk, which would in turn weigh on demand for feedstock methanol imports, traders said.

Future of China's MTO will depend on Iran and the US
The future of China's MTO sector will depend on securing feedstock to support its growth, which will come from traditional exporters and new sources from Americas. But exporters like Iran may be seeking their own MTO projects in its march up the value chain, reducing methanol exports.

Iran saw its export market share in China decline from 44% in 2015 to 30% in the first half of 2016 as competitors such as New Zealand, Oman, Saudi Arabia, and more importantly new players from the US, ramp up exports.

With the sanctions lifted, Iran will have more access to financing and technology and will seek to produce finished products rather than simply exporting feedstock. Already flush with ethylene, Iran may be looking at methanol-to-propylene projects to boost its propylene capacity, an area it currently lacks.

A proposal in the works calls for the construction of a petrochemical complex near Chabahar city, which if completed, would produce 1.6 million mt/year of methanol and power a 450,000 mt/year MTP and its associated PP plants. It will provide jobs and reduce dependence on imported PP, making it more economically and politically viable.

On the supply addition side, it is worth reiterating the importance of the new US methanol capacities. The US is poised to expand its capacity by 64% in 2017, from 5.75 million mt/year in 2016. This is seen as a remarkable increase as it comes at a time when traditional producers have limited natural gas feedstock.

These capacities will make the US a large net exporter — and the destination will most likely be Asia, considering the relatively stagnant demand from Europe. Moving forward, US producers will be an important partner for Chinese MTO plants.

Concluding remarks
This statistical analysis of S&P Global Platts data argues that changes in PP prices in China is linked with changes in methanol prices, and can be quantified in regression model. The model is meant to stimulate discussions on methanol price drivers such as MTOs, and as a general approach for analyzing other related commodities.

Evidence collected from the market suggests that China's MTO segment is the likely mechanism linking feedstock methanol
to polyolefins, with the relationship strong only after 2014, after the ramp-up in MTO production. The relationship also breaks down when polyolefin prices fall below the $980/mt threshold, presumably because of profitability.

MTO margins have been volatile but largely positive in 2015-2016, spurring an influx of export cargoes from traditional producers, but also new market entrants such as the US — who would likely be an important source of feedstock in the future. Therefore, MTO plants have been deemed the swing buyers of methanol by industry sources, a status they are likely to keep due to strong capacity growth in the next few years.

Looking forward to Q4, the margins seen for MTO units in the first half of 2016 may weaken as competition heats up from CTO and naphtha-based steam cracker polyolefin producers, capping China’s methanol imports.

STATISTICS APPENDIX

Are MTOs the driving force behind methanol pricing? Technical discussion of methanol vs polyolefin prices using a regression model, according to S&P Global economist Vincent Conti

Statistical treatment of price data
Purpose: Does the price of PP in China help to predict the price of methanol in China?

- **Null Hypothesis (H0):** PP raffia CFR FE Asia price is NOT predictive of Methanol CFR China price (Slope=0, p greater or equal to 5%).

- **Alternative Hypothesis (H1):** PP raffia CFR FE Asia price IS predictive of Methanol CFR China price (Slope not equal to 0, p smaller than 5%)

Causality: Methanol CFR China deemed the response variable, while PP Raffia CFR FE Asia deemed the independent variable (refer to main text for reasoning).

Measurement: Weekly average price of PP raffia CFR FE Asia and Methanol CFR China

Variable Transformation: Both the variables were time series that exhibited random walk behavior. As such, a regression of the price level of one on the other would lead to spurious results. To remedy this, the week-on-week percent changes of each price time series was taken, which removed the random walk — in technical terms, first differences were taken to convert the I(1) variables to I(0).

Control variable: The weekly percent changes in the response variable, methanol price, exhibited time-dependence on itself — meaning that if the price increased the previous week, it tends to increase again in the next. In technical terms, the first difference of methanol price is an AR(1) process. To account for this time-dependence, the lagged methanol price (1 week before) was included in the regression.

Regression Setup: The effect of PP price on Methanol price was allowed to vary depending on a threshold price. The regression could distinguish between the effect when the PP price was below $980/mt, from the effect when the PP price was above this threshold. The regression equation:

$$\Delta DMETHA_t = \alpha + \beta_1 \Delta DPP_t + \beta_2 \Delta DPP_t \cdot \text{Threshold}_t + \beta_3 DMETHA_{t-1} + \epsilon_t$$

where DMETHA is the percent change in price of methanol, DPP is the percent change in price of PP, and Threshold takes the value 1 when the PP price level is greater than $980/mt and 0 otherwise.

Here, $\alpha$ is a constant, $\beta_1$ is the effect of PP price changes on methanol price changes when the PP price level is less than $980/mt, and $\beta_1 + \beta_2$ is the effect of PP price changes on methanol price changes when the PP price level is above $980/mt.

That is, $\beta_1$ represents the extra boost to methanol prices whenever the PP price is above the threshold.

Therefore, the null hypothesis corresponds to having both $\beta_1$ and $\beta_2$ as insignificantly different from zero. The alternative hypothesis corresponds to either $\beta_1$ or $\beta_2$ being significantly different from zero.

Finding the Threshold: The same regression was run repeatedly, varying the threshold PP price level from $800/mt to $1,500/mt in steps of $10/mt. For each run, the p-values of both $\beta_1$ and $\beta_2$ were recorded. The threshold was taken as the first price at which $\beta_2$ was significantly different from zero at the same time that $\beta_1$ shifts from being significantly positive to insignificant, and stays that way (if such a price point occurs at all).

Main Regression Results: Price data 2014-2016
Dependent Variable: DMETHA
Sample (adjusted): 1/12/2014 8/14/2016
Included observations: 136 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

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<th>Std. Error</th>
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R-squared | 0.465444 | Mean dependent var | -0.006147 |
Adjusted R-squared | 0.453295 | S.D. dependent var | 0.030777 |

The coefficient of DPP ($\beta_1$) had a p-value of 0.35, suggesting that it is insignificantly different from zero. That is, there was no evidence for an effect of PP price changes on methanol price changes when the PP price level is less than $980/mt. Meanwhile, the coefficient of DPP*Threshold ($\beta_2$) had a p-value of 0.01, suggesting strong evidence for an effect of PP price changes on methanol price changes when the PP price level is above $980/mt.
The regression model was then simplified by removing all observations for which the PP price was below the threshold, and then running the following equation:

\[
DMETHA_t = \alpha + \beta_1 DPP_t + \beta_3 DMETHA_{t-1} + \epsilon_t
\]

**Dependent Variable:** DMETHA  
**Sample:** 1/05/2014 8/14/2016 IF PP>980  
**Included observations:** 93  
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

The final estimate for \(\beta_1\) was 0.68. With the standard error of 0.19, with 95% confidence, the true value of \(\beta_1\) would be between 0.31 and 1.05.

The estimate for time-dependence of methanol price movements, \(\beta_3\), was 0.46.

R-squared was around 0.5, suggesting that the regression was able to explain half of the total variation in price movements of methanol.

**Interpretation:** The coefficient estimate of 0.68 can be interpreted as follows. A 1 percentage point acceleration/deceleration in the price change of PP would, on average, result in a 0.68 percentage point acceleration/deceleration in the price change of methanol. That is:

For example, if PP price increased 1% last week and then 2% this week, while methanol price also rose 1% last week. The model predicts that methanol price would rise 1.68% this week.

As a predictive tool, one could use:

\[
DMETHA_t = 0 + 0.68*DPP_t + 0.46*DMETHA_{t-1}
\]

For example, PP price fell 0.17% in the week to June 28, 2015. The week before (week to June 21), methanol prices rose 0.06%. Plugging these into the above equation, one would estimate that the methanol price change for the week to June 28 was -0.01% (almost no change). The actual change was +0.06%, also nearly flat from the previous week.

**Comparison across periods**

The results from the regression above were compared those obtained by running the same equation, using data from October 2011-December 2012 (pre-MTO). The results of the latter are presented in the following table.

For the pre-MTO time period, the coefficient on DPP was statistically no different from zero, with a p-value of 0.96. As such, there was no evidence for an effect of PP price movements on methanol price movements during that period.

Moreover, R-squared for the regression was very low, further suggesting that a regression using PP prices would be unable to explain the variation in methanol prices during those two years.

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R-squared: 0.533855  
Adjusted R-squared: 0.523497

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</tr>
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</table>

R-squared: 0.162183  
Adjusted R-squared: 0.132393

For the pre-MTO time period, the coefficient on DPP was statistically no different from zero, with a p-value of 0.96. As such, there was no evidence for an effect of PP price movements on methanol price movements during that period.

Moreover, R-squared for the regression was very low, further suggesting that a regression using PP prices would be unable to explain the variation in methanol prices during those two years.