Title: Polypropylene price dynamics: input costs or downstream demand?

Lurion De Mello lurion.demello@mq.edu.au and Ronald Ripple ron-ripple@utulsa.edu

Non-technical summary

This paper looks at the price dynamics between polypropylene (PP), propylene, naphtha and crude oil together with some demand proxies that utilise PP products in Europe and Asia. Prior research has predominantly focused on the price dynamics between crude oil and refined products such as heating oil, gasoline and diesel in a bivariate and multivariate context. The petrochemical arm of the refined product market also forms an important part of the downstream oil industry as these products are further refined into various plastics and polymer products used in many applications. Naphtha is cracked to produce olefins, which constitute mainly of ethylene and propylene. Propylene in turn is used to manufacture PP which is a key input in manufacturing parts used in the car industry and in making items such as travel luggage, drinking straws, bottle caps and food containers. The paper is motivated by the important role propylene and PP industries play in the manufacturing of various downstream products. The paper makes an important contribution by helping producers in having a better understanding of how input costs and demand drive the product prices. These propylene and PP industries do not have an established futures markets and usually rely on crude oil and heating oil futures contracts to manage and hedge their price risk.

The paper focuses on Asia and Europe given the heavy dependence on naphtha as a key feedstock. The cracking of liquid feedstock like naphtha is less common in the Middle East and North America as Natural gas liquids (NGLs) and ethane are the major inputs for the petrochemical value chain. Ethane is the natural choice of feedstock given the increasing discoveries of shale gas particularly in the United Sates.

Our paper utilises time series analysis tools such as Generalised Variance Decompositions (GVDs), Generalised Impulse Response Functions (GIRFs) and Persistence Profiles to test the prices dynamics of the PP value chain. Prior to these steps we estimate a time-series model based on the vector error-correction model which tests long-run relationship between the variables.

We use monthly data from May 1995 to January 2016 based on the earliest common start date across all the series. All data is sourced from Thomson Reuters Datastream. Details of the data are presented in Table 1 of the paper with explanations provided on the various manipulations undertaken to make the different prices uniform. All prices are converted to logs when estimating the model and are seasonally adjusted. For the PP demand proxies, we use new car registrations based on cars manufactured only in Europe and Japanese film production as this was the only data that was available representing the PP consuming industry. The authors are happy to supply Table 1 upon request.

The restricted VAR model finds three cointegrating vectors (CV) which leads to three error correction terms. The first CV looks at the relationship between propylene, PP and the demand proxy and the second CV between propylene, crude oil and demand proxy. Finally, the third CV looks at naphtha, crude oil and the demand proxy. The CV are setup by imposing zero restrictions on the remaining variables in each CV. The results from the error correction term indicate that PP prices adjust marginally faster in Europe than Asia perhaps due to changes in demand conditions of other downstream sectors using propylene as a feedstock. Input costs tend to drive the prices dynamics in Europe with demand have little impact on the price of PP. The opposite result is found in Asia where input costs are the bigger drivers of PP.

From the GVD output for Asia the variance of PP is predominantly explained by propylene and through its innovations in the beginning, but through time propylene, naphtha, and crude oil prices play an equally shared role in explaining movements in PP prices. When propylene prices are shocked, 51.35% of the variation is self-explained at the beginning with moderate influence coming from PP and majority of the change being driven by naphtha and crude oil price. Therefore, input costs are the primary drivers of prices with little or negligible influence coming from downstream demand factors. The shock to the equation error in naphtha and crude oil tends to have an equal impact on each other given the close link between the two. The GVD results for Europe show similar results compared to the Asian market. Shocks to PP prices are initially mostly self-explained but through time naphtha and crude oil tend to have a greater influence with propylene playing a less significant role.

The findings have strong policy implications, particularly for countries like China who is the biggest PP importer in the world. The Middle East, in particular, Saudi Arabia and Iran are keeping their investments in the sector stable despite the low oil prices in 2015-16. Having a better understanding of the dynamic interaction over a long-run period will help them in betting gauging production of various petrochemicals to reach their profit targets. The inclusion of demand proxies in the estimated model gives an opportunity to test if PP consuming industries effects are just as likely to have some impact on PP prices which in turn impact immediate feedstocks like propylene.

The biggest challenge facing the petrochemical industry is the feedstock cost of naphtha as this depresses profit margins and damages competitiveness. The increasing cost during the high oil price period has led petrochemical plants to invest in condensate splitters, with South Korea, China and Singapore building distillation units that can process large volumes of condensate along with liquefied natural gas (LNG) for just one-seventh of the price of a typical large refinery. With these facilities coming online in late 2016, condensate sales from top suppliers such as Qatar, also the world's biggest LNG exporter, are slated to fall as the nation feeds local demand, which is expected to rise, with more splitters due to come online. (BMI Singapore Petrochemicals Annual Report 2013).[1] The recent surge in shale gas discoveries has led to increasing investment in ethane and propane based crackers that are likely to produce petrochemicals sold at margins based on the significantly more expensive naphtha. This abundant availability of natural gas supplies has given the U.S. a much bigger margin for its downstream business and will increase the profitability of the industry compared to Asia and Europe. PP margins have been healthy globally given the lack of capacity in this market as most investments have been in the propylene sectors creating a vast oversupply. This lack of capacity is one of the reasons why the spread between propylene and PP has grown in recent times.

1 BMI refers to Business Monitor International