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Predicting ARA Oil Stocks Changes

A correlation between ARA oil stocks and Rhine barge movements

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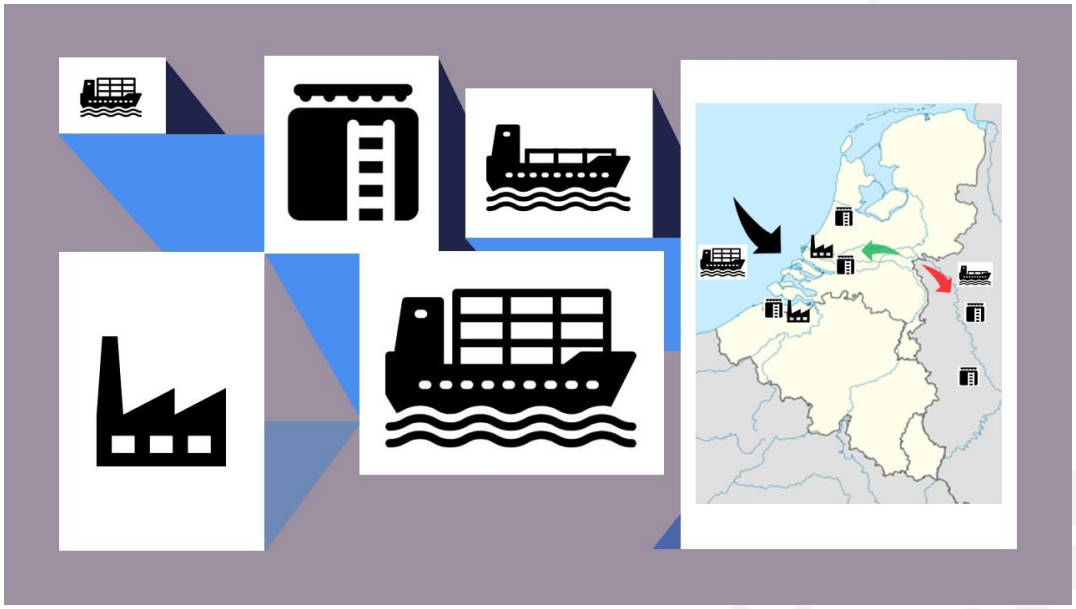
Rhine Flow Service and ARA Stocks

The ARA region, with its excellent connections to international waters, is Europe's main import hub for liquid oil products. Most of European's oil products demand is served through this cooperation of ports, with Germany being the largest importer of ARA throughput. Germany has strong demand for gasoil, and the majority of its gasoil demand is served by imports from the ports of Amsterdam, Rotterdam and Antwerp. Whereas the use of pipelines and trains are less common for the transportation of gasoil to the hinterland, most of the deliveries are made using river barges. PJK's Rhine Flow Service measures these in- and outflows of gasoil barges from and to Germany, and provides weekly statistics on gasoil flows going up and down the River Rhine. Other products covered in the Rhine Flow Service are gasoline, fuel oil, jet-kerosene, LPG and naphtha.

Rhine Flow Service provides weekly statistics on oil products flows going up and down the River Rhine

Most of the oil product volumes that enter the ARA region, be it by local production or imports from overseas, are temporarily stored in tanks before being sold and transported to the next destination. North-Western Europe has great demand for diesel and cannot fulfill this demand through local production. Gasoil is therefore the region's largest liquid bulk import category, with large cargo vessels structurally coming in from the U.S., Russia, the Baltics, and the Middle East. Such large import volumes lead to significant volumes of gasoil storage. PJK structurally measures these ARA storage levels, of which gasoil inventories roughly are triple the size of any other stock level in this region.

Germany is by far the largest consumer of ARA gasoil imports. Put differently, most of the gasoil outflow from ARA storage tanks is a result of barges carrying gasoil up the Rhine. The outflow to Germany therefore may have a significant effect on the ARA gasoil inventories. This article investigates this relation between the barge gasoil outflows from ARA and the changes in ARA gasoil inventories. When analyzing these data sets we find **a significant relation between changes in ARA gasoil inventories and the barge flow of gasoil to Germany.** This relation can be used to predict changes in inventory levels



Relation between ARA gasoil stocks and gasoil flows along the Rhine

To investigate how the outflow of gasoil to the hinterland and the ARA gasoil stock changes are related, we analyze Rhine flow and ARA stocks data from January 2018 up until the first week of October 2018. As both the Rhine Flow Service and ARA Stocks are published on a weekly basis we use a total of 38 weeks of data for each data set.

Changes in gasoil inventories are correlated to net-export flows up the Rhine

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Before we look at the data we identify the causes of changes in ARA gasoil inventories. The changes in ARA gasoil inventories can be described as

$$\begin{aligned}\Delta Inv_{gasoil} &= Inflow_{gasoil} - Outflow_{gasoil} \\ &\sim Production_{gasoil} - Consumption_{gasoil} + Imports_{gasoil} - Exports_{gasoil}\end{aligned}$$

In other words, the inventory changes are the result of production and consumption changes in the region, as well as the result of import and export flows of gasoil. The production of gasoil consists of the local refining output. Furthermore, the imports of gasoil primarily occur through ocean going cargoes while a vast majority of exports consist of barges along the Rhine. The formula can therefore be rewritten as

$$\Delta Inv_{gasoil} = Refining\ output - ARA\ Consumption + Net\ Import_{vessels} - Net\ Export_{barges}$$

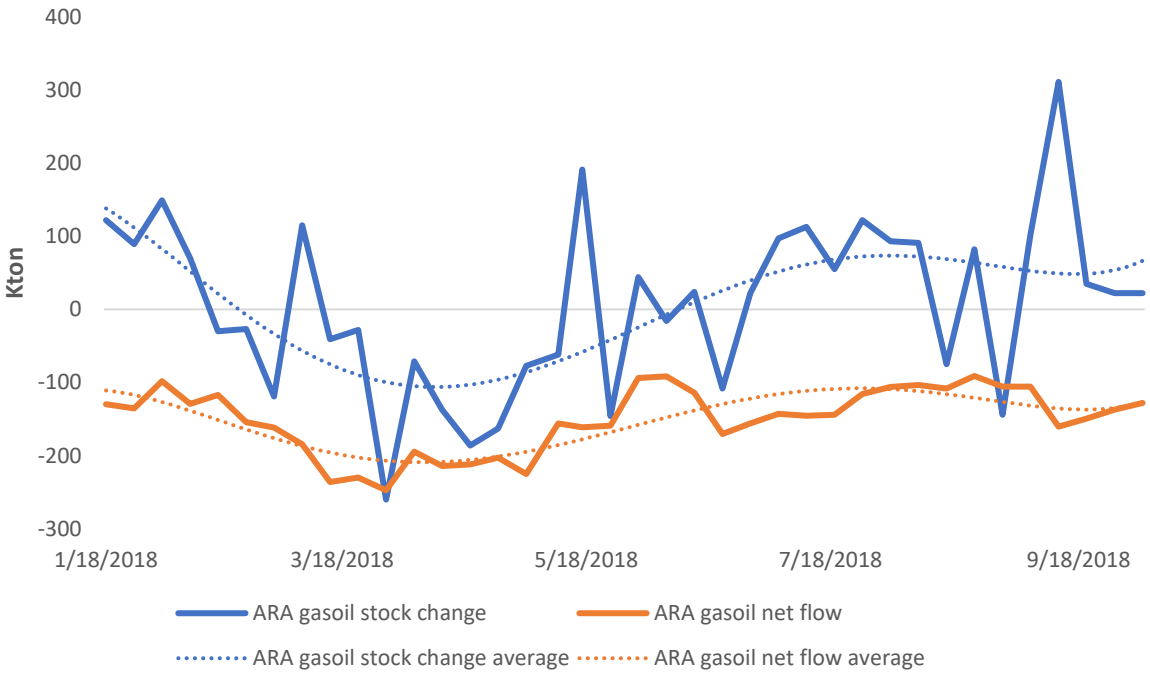
Consumption and production of gasoil are rather stable compared to the gasoil vessel and barge flows. This leads to the following situation, in which the ARA gasoil inventory changes at time t can be approximated by the differences in import and export volumes, corrected for their averages:

$$\Delta Inv_{t,gasoil} \approx \left(Net\ Imports_{t,vessels} - \mu_{vessels}\right) - \left(Net\ Exports_{t,barges} - \mu_{barges}\right),$$

where $\mu_{vessels}$ is the average of net imports with vessels and μ_{barges} is the average of net exports with barges. Identifying the changes in ARA gasoil inventories has led us to think that the changes are highly influenced by the imports and export volumes, and thus by the outflow of gasoil along the Rhine. Based on this approximate formula we expect that gasoil inventory changes are positive when the outflow along the Rhine is relatively modest, and negative when the Rhine outflow is relatively high. The image below confirms this relation, where the ARA net gasoil flow is calculated as the difference between incoming and outgoing barges carrying gasoil. Since the inflow of gasoil barges is generally zero, we obtain a negative net outflow of gasoil.

We see that the ARA stocks are generally decreasing when the net flow to Germany intensifies, and increasing when the net flow is more modest. Looking at the moving averages we see even more clearly the extent to which both timeseries move in the same direction. The presumed relation between the ARA stocks and Rhine flow has been confirmed by visualizing data.

Figure 1: ARA gasoil stock changes and net gasoil flow along the Rhine. Source: PJK International



A model that relates the net gasoil flow to the ARA stocks

By visualizing the data a relation between the ARA gasoil stocks and net flow along the Rhine has been demonstrated. The next step is to quantify the visible relation in Figure 1 using a model.

We have performed a linear regression analysis in which we try to explain the changes in ARA gasoil stocks with the net flow of gasoil along the Rhine during week t, $Net\ Flow_{t,Rhine}$, which is calculated as the barge imports minus the barge exports. Since the exports are larger than the imports, the net flow consists of negative numbers.

The model can be described as

$$\Delta Inv_{t,gasoil} = \alpha + \beta * Net\ Flow_{t,Rhine} + \varepsilon,$$

where α is the average change in gasoil inventories when the net flow of gasoil to Germany is zero, β is the coefficient that relates the Rhine flow to the stock changes and ε captures the errors. α can be seen as the average net outflow of gasoil to Germany multiplied by β.

The analysis confirms the existence of a significant relation between gasoil barge flows and stock changes

The model is estimated using the least squares procedure, in which the squared estimation errors of the model are minimized. Minimizing squared errors allows relatively large errors to be penalized more than small errors. The results of the regression analysis are presented below.

Regression analysis	
Correlation	0.49
R^2	0.24
Observations	38

	Coefficients	*Standard Error*	*T-statistics*	*P-value*	*lowest 95%*	*Highest 95%*
Intercept	204.71	60.92	3.36	0.00	81.17	328.26
Rhine net flow	1.31	0.39	3.37	0.00	0.52	2.10

Converting the model outcome back to the formula for inventory changes presented above, we find that changes in the ARA gasoil inventory levels relate to the outflow of gasoil along the Rhine as

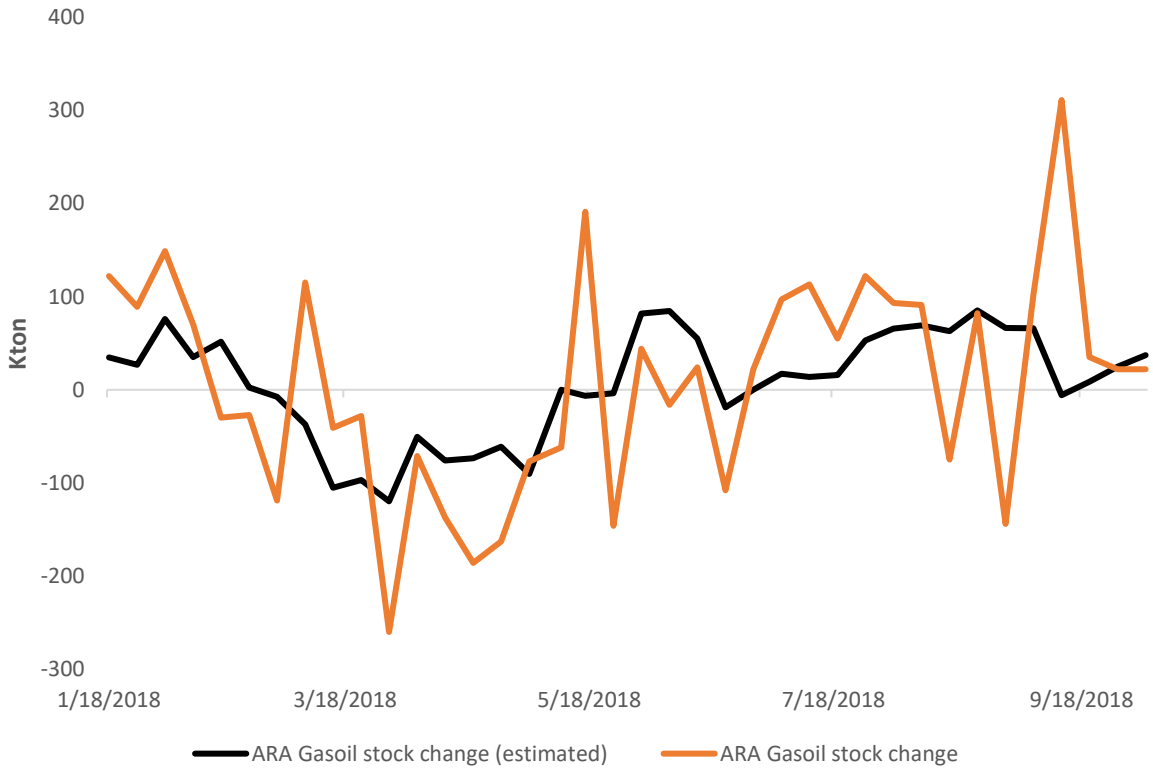
$$\Delta Inv_{gasoil} = 204.71 + 1.31 * Net\ Flow_{Rhine}.$$

The positive coefficient of 1.31 confirms that the gasoil stock changes and net flow along the Rhine move in the same direction. When the outflow of gasoil from ARA intensifies, a larger decline in ARA gasoil inventories is expected. This is also seen in the positive correlation of 0.49. A correlation coefficient can range from -1 to +1, and indicates the extent to which both time series move together. A correlation of 0.49 is therefore indicates a strong positive relation. When the weekly net flow of gasoil to Germany is zero we expect the stocks to increase with 204.71kton per week.

The model parameters, α (204.71) and β (1.31), are both highly significant as their respective P-values of 0.00 demonstrate. The significance of the model parameters indicates that model finds a statistically significant relation between the changes in ARA gasoil inventories and gasoil flow up the Rhine.

The regression analysis shows the existence of a linear relation between the weekly ARA gasoil inventory changes and the weekly net flow of gasoil along the Rhine. The most important conclusion from this is that the ARA gasoil stock changes can be predicted from the flow of gasoil along the Rhine.

Figure 2: ARA gasoil stock changes and the estimated stock changes based on the linear model. Source: PJK International



Footnote:

For a complete analysis of the stock changes, one should also estimate the impact of vessel movements, local consumption and local production.

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