DSC5211C Workshop 5

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VAR & COINTEGRATION

1. The metal prices are non-stationary.

2. Johansen Cointegration Test

Sample (adjusted): 1990M03 2018M12
Included observations: 346 after adjustments
Trend assumption: No deterministic trend (restricted constant)
Series: LOG(COPPER) LOG(LEAD) LOG(TIN) LOG(ZINC)
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.078118	54.58767	54.07904	0.0450
At most 1	0.044796	26.44455	35.19275	0.3177
At most 2	0.026528	10.58727	20.26184	0.5822
At most 3	0.003706	1.284661	9.164546	0.9101

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Conclusion: There is at most one cointegrating equation in the system of four metal prices.

3. Derive the cointegration model with 1 cointegration equation.

Vector Error Correction Estimates
Date: 02/16/19 Time: 15:46
Sample (adjusted): 1990M03 2018M12
Included observations: 346 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LOG(COPPER(-1))	1.000000
LOG(LEAD(-1))	-2.535663 (0.45645) [-5.55520]
LOG(TIN(-1))	1.644632 (0.40814) [4.02953]
LOG(ZINC(-1))	0.166074 (0.34076) [0.48736]
C	-6.925281 (1.93706) [-3.57515]

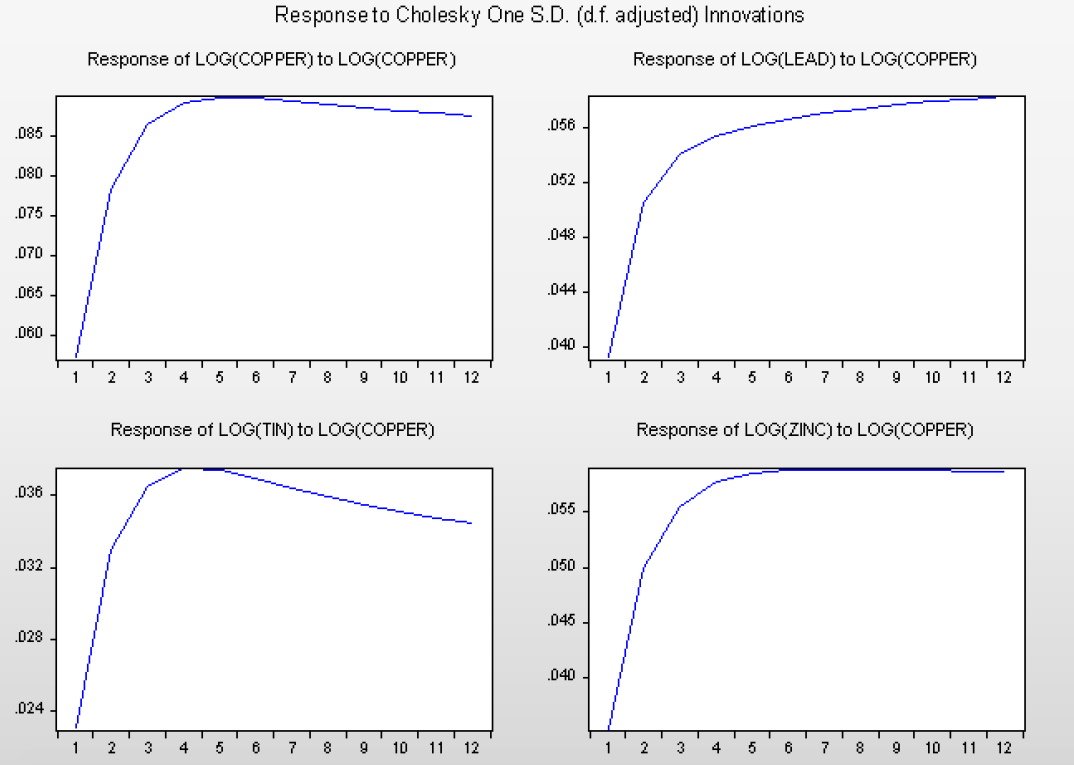
Log(Copper(t)) = -2.54Log(Lead(t-1)) + 1.64Log(Tin(t - 1)) + 0.17Log(Zinc(t - 1)) - 6.93

From the t-statistics and standard error of coefficients, it can be observed that copper price is negatively correlated with lead price, and positively correlated with tin price. Zinc doesn't have significant influence on the copper price.

Error Correction:	D(LOG(COP...	D(LOG(LEAD))	D(LOG(TIN))	D(LOG(ZINC))
CointEq1	-0.018218	0.013266	-0.025830	-0.004341
	(0.00820)	(0.00982)	(0.00746)	(0.00838)
	[-2.22041]	[1.35031]	[-3.46049]	[-0.51821]
D(LOG(COPPER(-1)))	0.420624	0.089441	0.091521	0.191225
	(0.06844)	(0.08195)	(0.06226)	(0.06987)
	[6.14621]	[1.09147]	[1.46997]	[2.73686]
D(LOG(LEAD(-1)))	-0.089978	0.227445	0.016599	-0.052085
	(0.05860)	(0.07017)	(0.05331)	(0.05983)
	[-1.53538]	[3.24128]	[0.31135]	[-0.87054]
D(LOG(TIN(-1)))	-0.021968	-0.153571	0.200727	-0.221108
	(0.06506)	(0.07791)	(0.05919)	(0.06643)
	[-0.33765]	[-1.97125]	[3.39117]	[-3.32867]
D(LOG(ZINC(-1)))	0.032673	0.024900	-0.016137	0.303236
	(0.06797)	(0.08139)	(0.06184)	(0.06939)
	[0.48070]	[0.30595]	[-0.26096]	[4.36983]

System of equation results above indicate that Zinc price is not influential on any of the other three metal prices. Tin price has the strongest influence on Lead price and Zinc price. It emerges as the main drive of prices.

4. Impulse Response to Log(Copper)



A. Log(Copper) response to increase in Log (Copper) is prominent during the first three months and quickly quiet off. Copper price increases significantly at beginning. Then it reversed the the impact slightly toward the end of 12 months. It starts to drop due to the fact that when impact of copper price has realize on other metal prices, through system of equation, those changes also impact copper price back in the long term. Coefficients of lead and tin price change are negative on copper price change, that explains the reversion.

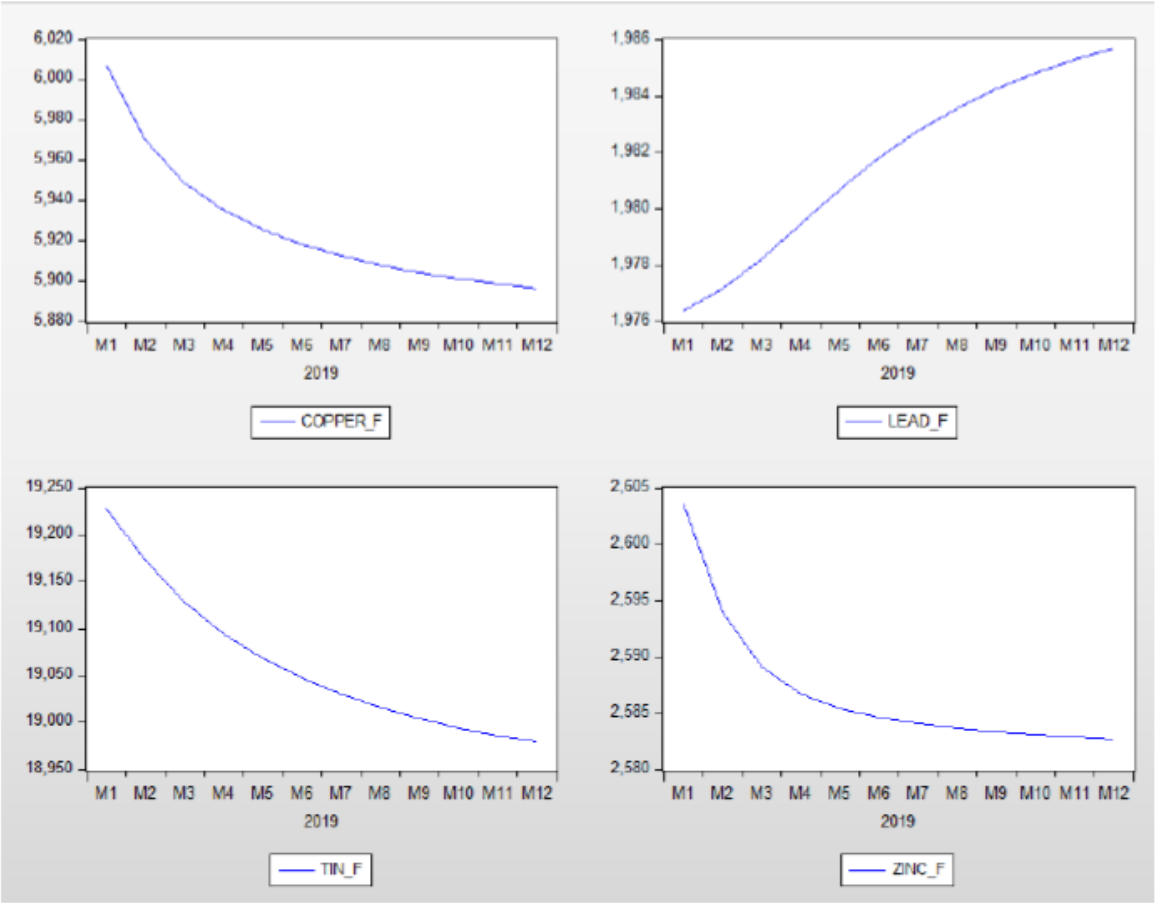
B. Log(Lead) response to increase in Log(Copper) demonstrates a strong impact in the first few months as can be seen by the fast increase in Log(Lead). The impact fades out but still shows an increase in the later periods.

C. Log(Tin) response to increase in Log(Copper) follows the same pattern as for Lead and Copper price. But after 4th month, after the impact has peaked, it shows a observable trend of decrease in tin price, reverses some of the impact caused previously.

D. Log(Zinc) response to increase in Log(Copper) also follows the same trend for the first 4 period, but the impact stays the same after it has reached its peak. Zinc price is highly influenced and to a certain degree determined by copper price.

E. In general, the impact of metal price changes are significant over the first 3 month and gradually fade off. It also conforms to the positive coefficients of D(LOG(COPPER) to all other 3 DLOG in the system of equation above.

5. Out-of-sample Forecasts for 2019



Following from conclusion earlier, tin price is the main driver in this system. Tin price is predicted to go down and from the negative coefficients of its impact on lead price, lead price should change inversely. This explains why predicted lead price goes up. As for copper, as indicated by the equation in part 3, in the long-term, its price is negatively correlated with lead price and positively correlated by tin price, with the decreased predicted tin price and increasing lead price, copper price is predicted to go down. Zinc price is influenced by its own price and copper price. The positive coefficient of DLOG(Copper(-1)) to DLOG(ZINC(-1)) drives the downward trend in predicted zinc price.