

## Ethylene Supply in a Fluid Context: Implications of Shale Gas and Climate Change

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# Ethylene supply in a fluid context: implications of shale gas and climate change

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This appendix is for readers who would like additional details on the base VEC model output. Data files may be requested from the author.

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**Table 1**  
**Coefficients for the lagged endogenous variables**

First Lag								
	Ethane/Ethylene Supply	Cushing, OK WTI Crude Oil Price	Natural Gas Liquids Quantity	Ethane/Ethylene Stocks	GDP/PCE per cap	Resident Population	Natural Gas Price	
Ethane/Ethylene Supply	1.112	0.062	-0.839	0.711	0.515	-39.633	-0.075	
Cushing, OK WTI Crude Price	-0.087	1.245	0.026	-0.255	0.191	3.715	-0.043	
Natural Gas Liquids Quantity	0.209	0.071	0.106	0.257	0.053	20.507	-0.078	
Ethane/Ethylene Stocks	-0.145	0.083	0.130	1.254	-0.492	86.103	-0.012	
GDP/PCE per cap	-0.007	0.066	0.001	-0.031	0.760	2.153	0.006	
Resident Population	0.000	0.000	0.000	0.000	0.001	1.901	0.000	
Natural Gas Price	-0.103	0.139	0.057	-0.173	-0.486	-126.589	1.041	
Second Lag								
	Ethane/Ethylene Supply	Cushing, OK WTI Crude Oil Price	Natural Gas Liquids Quantity	Ethane/Ethylene Stocks	GDP/PCE per cap	Resident Population	Natural Gas Price	
Ethane/Ethylene Supply	-0.405	-0.037	0.904	-0.987	-0.750	233.532	0.094	
Cushing, OK WTI Crude Price	0.132	-0.247	-0.127	0.402	-0.208	-39.840	0.041	
Natural Gas Liquids Quantity	-0.233	-0.010	0.742	-0.506	-0.347	-26.810	0.070	
Ethane/Ethylene Stocks	0.262	-0.082	-0.290	-0.128	0.458	-259.608	-0.009	
GDP/PCE per cap	0.034	-0.057	-0.023	0.051	0.146	-7.887	0.009	
Resident Population	0.000	0.000	-0.001	0.000	-0.001	-0.952	0.000	
Natural Gas Price	0.106	-0.061	0.000	0.327	0.072	242.455	-0.204	
Third Lag								
	Ethane/Ethylene Supply	Cushing, OK WTI Crude Oil Price	Natural Gas Liquids Quantity	Ethane/Ethylene Stocks	GDP/PCE per cap	Resident Population	Natural Gas Price	
Ethane/Ethylene Supply	0.112	-0.012	0.011	0.312	-0.013	-192.551	-0.013	
Cushing, OK WTI Crude Price	-0.003	0.000	0.084	-0.155	0.075	35.809	0.001	
Natural Gas Liquids Quantity	0.012	-0.060	0.157	0.252	0.277	6.397	0.008	
Ethane/Ethylene Stocks	-0.009	-0.009	0.114	-0.147	0.182	172.705	0.018	
GDP/PCE per cap	-0.017	-0.009	0.018	-0.022	0.108	5.656	-0.015	
Resident Population	0.000	0.000	0.000	0.000	0.000	0.050	0.000	
Natural Gas Price	0.016	-0.080	-0.065	-0.158	0.440	-116.008	0.162	

**Table 2**  
**OLS regression of the unrestricted VECM**

Response EthaEthySupQL. d :

Call:

```
lm(formula = EthaEthySupQL. d ~ EthaEthySupQL. dl 1 + WTI CrudePL. dl 1 +
  NGLLRGQL. dl 1 + EthaEthyStockQL. dl 1 + GDPGOODSCAPL. dl 1 + Monthly. PopL. d
  l 1 +
  GasCityGatePL. dl 1 + EthaEthySupQL. dl 2 + WTI CrudePL. dl 2 +
  NGLLRGQL. dl 2 + EthaEthyStockQL. dl 2 + GDPGOODSCAPL. dl 2 + Monthly. PopL. d
  l 2 +
  GasCityGatePL. dl 2 + EthaEthySupQL. l 3 + WTI CrudePL. l 3 + NGLLRGQL. l 3 +
  EthaEthyStockQL. l 3 + GDPGOODSCAPL. l 3 + Monthly. PopL. l 3 +
  GasCityGatePL. l 3 + constant - 1, data = data.mat)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.44762	-0.04391	0.00002	0.04408	0.20832

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
EthaEthySupQL. dl 1	0.021700	0.178563	0.122	0.903352
WTI CrudePL. dl 1	0.054377	0.061017	0.891	0.373501
NGLLRGQL. dl 1	-0.794320	0.230367	-3.448	0.000639 ***
EthaEthyStockQL. dl 1	0.653278	0.189325	3.451	0.000634 ***
GDPGOODSCAPL. dl 1	0.492358	0.385661	1.277	0.202639
Monthly. PopL. dl 1	-85.552486	55.140567	-1.552	0.121753
GasCityGatePL. dl 1	-0.087803	0.062982	-1.394	0.164244
EthaEthySupQL. dl 2	-0.433139	0.120773	-3.586	0.000387 ***
WTI CrudePL. dl 2	0.039683	0.064902	0.611	0.541341
NGLLRGQL. dl 2	0.103032	0.164171	0.628	0.530714
EthaEthyStockQL. dl 2	-0.302241	0.173149	-1.746	0.081840 .
GDPGOODSCAPL. dl 2	-0.191654	0.378125	-0.507	0.612602
Monthly. PopL. dl 2	175.211678	54.776490	3.199	0.001518 **
GasCityGatePL. dl 2	-0.007624	0.061731	-0.124	0.901787
EthaEthySupQL. l 3	-0.345472	0.119345	-2.895	0.004053 **
WTI CrudePL. l 3	0.008620	0.018713	0.461	0.645345
NGLLRGQL. l 3	0.065495	0.119455	0.548	0.583878
EthaEthyStockQL. l 3	0.054754	0.036675	1.493	0.136430
GDPGOODSCAPL. l 3	-0.291880	0.132117	-2.209	0.027859 *
Monthly. PopL. l 3	2.039433	0.584817	3.487	0.000555 ***
GasCityGatePL. l 3	-0.043480	0.037413	-1.162	0.246022
constant	-34.920000	10.019848	-3.485	0.000560 ***

---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.08156 on 323 degrees of freedom

Multiple R-squared: 0.3621, Adjusted R-squared: 0.3187

F-statistic: 8.334 on 22 and 323 DF, p-value: < 2.2e-16

Response WTI CrudePL. d :

Call:

```
lm(formula = WTI CrudePL. d ~ EthaEthySupQL. dl 1 + WTI CrudePL. dl 1 +
  NGLLRGQL. dl 1 + EthaEthyStockQL. dl 1 + GDPGOODSCAPL. dl 1 + Monthly. PopL. d
  l 1 +
  GasCityGatePL. dl 1 + EthaEthySupQL. dl 2 + WTI CrudePL. dl 2 +
  NGLLRGQL. dl 2 + EthaEthyStockQL. dl 2 + GDPGOODSCAPL. dl 2 + Monthly. PopL. d
  l 2 +
  GasCityGatePL. dl 2 + EthaEthySupQL. l 3 + WTI CrudePL. l 3 + NGLLRGQL. l 3 +
  EthaEthyStockQL. l 3 + GDPGOODSCAPL. l 3 + Monthly. PopL. l 3 +
  GasCityGatePL. l 3 + constant - 1, data = data.mat)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.25591	-0.04697	0.00301	0.04942	0.37509

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
EthaEthySupQL. dl 1	-0.095401	0.174763	-0.546	0.585518
WTICrudePL. dl 1	0.211585	0.059719	3.543	0.000454 ***
NGLLRQL. dl 1	0.017217	0.225464	0.076	0.939177
EthaEthyStockQL. dl 1	-0.242545	0.185296	-1.309	0.191479
GDPGOODSCAPL. dl 1	0.165301	0.377454	0.438	0.661724
Monthly. PopL. dl 1	-2.170152	53.967092	-0.040	0.967949
GasCityGatePL. dl 1	-0.044423	0.061641	-0.721	0.471637
EthaEthySupQL. dl 2	0.129899	0.118203	1.099	0.272610
WTICrudePL. dl 2	-0.017535	0.063521	-0.276	0.782687
NGLLRQL. dl 2	-0.251750	0.160677	-1.567	0.118139
EthaEthyStockQL. dl 2	0.257404	0.169465	1.519	0.129759
GDPGOODSCAPL. dl 2	-0.035320	0.370078	-0.095	0.924025
Monthly. PopL. dl 2	-45.389126	53.610764	-0.847	0.397822
GasCityGatePL. dl 2	-0.002284	0.060417	-0.038	0.969861
EthaEthySupQL. l3	0.139289	0.116805	1.192	0.233944
WTICrudePL. l3	-0.026631	0.018314	-1.454	0.146887
NGLLRQL. l3	-0.228014	0.116913	-1.950	0.052006
EthaEthyStockQL. l3	0.010315	0.035895	0.287	0.774015
GDPGOODSCAPL. l3	-0.065908	0.129305	-0.510	0.610605
Monthly. PopL. l3	0.406085	0.572372	0.709	0.478540
GasCityGatePL. l3	-0.014640	0.036616	-0.400	0.689551
constant	-6.143019	9.806610	-0.626	0.531484

---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.07983 on 323 degrees of freedom  
Multiple R-squared: 0.1344, Adjusted R-squared: 0.07546  
F-statistic: 2.28 on 22 and 323 DF, p-value: 0.00107

Response NGLLRQL. d :

Call:

```
lm(formula = NGLLRQL. d ~ EthaEthySupQL. dl 1 + WTICrudePL. dl 1 +
  NGLLRQL. dl 1 + EthaEthyStockQL. dl 1 + GDPGOODSCAPL. dl 1 + Monthly. PopL. d
  l 1 +
  GasCityGatePL. dl 1 + EthaEthySupQL. dl 2 + WTICrudePL. dl 2 +
  NGLLRQL. dl 2 + EthaEthyStockQL. dl 2 + GDPGOODSCAPL. dl 2 + Monthly. PopL. d
  l 2 +
  GasCityGatePL. dl 2 + EthaEthySupQL. l3 + WTICrudePL. l3 + NGLLRQL. l3 +
  EthaEthyStockQL. l3 + GDPGOODSCAPL. l3 + Monthly. PopL. l3 +
  GasCityGatePL. l3 + constant - 1, data = data.mat)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.224565	-0.021570	0.007975	0.029106	0.142053

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
EthaEthySupQL. dl 1	0.08721	0.10291	0.848	0.397336
WTICrudePL. dl 1	0.07152	0.03516	2.034	0.042784 *
NGLLRQL. dl 1	-0.82096	0.13276	-6.184	1.89e-09 ***
EthaEthyStockQL. dl 1	0.11998	0.10911	1.100	0.272323
GDPGOODSCAPL. dl 1	0.10188	0.22226	0.458	0.646995
Monthly. PopL. dl 1	-11.94373	31.77767	-0.376	0.707273
GasCityGatePL. dl 1	-0.10843	0.03630	-2.987	0.003029 **
EthaEthySupQL. dl 2	-0.20713	0.06960	-2.976	0.003141 **
WTICrudePL. dl 2	0.07779	0.03740	2.080	0.038329 *
NGLLRQL. dl 2	-0.06951	0.09461	-0.735	0.463050
EthaEthyStockQL. dl 2	-0.32754	0.09979	-3.282	0.001142 **
GDPGOODSCAPL. dl 2	-0.24161	0.21791	-1.109	0.268370
Monthly. PopL. dl 2	-4.49685	31.56785	-0.142	0.886813
GasCityGatePL. dl 2	-0.04952	0.03558	-1.392	0.164848
EthaEthySupQL. l3	-0.26052	0.06878	-3.788	0.000181 ***
WTICrudePL. l3	0.01667	0.01078	1.546	0.123189
NGLLRQL. l3	0.09877	0.06884	1.435	0.152349
EthaEthyStockQL. l3	-0.05243	0.02114	-2.480	0.013629 *

```

GDPGOODSCAPL.l3      -0.05214      0.07614  -0.685  0.493950
Monthly.PopL.l3      0.90983      0.33703   2.700  0.007309 **
GasCityGatePL.l3    -0.07568      0.02156  -3.510  0.000511 ***
constant             -15.12550      5.77447  -2.619  0.009225 **

```

---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.047 on 323 degrees of freedom  
Multiple R-squared: 0.3738, Adjusted R-squared: 0.3312  
F-statistic: 8.765 on 22 and 323 DF, p-value: < 2.2e-16

Response EthaEhtyStockQL.d :

Call:

```

lm(formula = EthaEhtyStockQL.d ~ EthaEhtySupQL.dl1 + WTI CrudePL.dl1 +
  NGLLRGQL.dl1 + EthaEhtyStockQL.dl1 + GDPGOODSCAPL.dl1 + Monthly.PopL.d
l1 +
  GasCityGatePL.dl1 + EthaEhtySupQL.dl2 + WTI CrudePL.dl2 +
  NGLLRGQL.dl2 + EthaEhtyStockQL.dl2 + GDPGOODSCAPL.dl2 + Monthly.PopL.d
l2 +
  GasCityGatePL.dl2 + EthaEhtySupQL.l3 + WTI CrudePL.l3 + NGLLRGQL.l3 +
  EthaEhtyStockQL.l3 + GDPGOODSCAPL.l3 + Monthly.PopL.l3 +
  GasCityGatePL.l3 + constant - 1, data = data.mat)

```

Residuals:

Min	1Q	Median	3Q	Max
-0.195285	-0.034093	0.000761	0.038908	0.189448

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
EthaEhtySupQL.dl1	-0.27108	0.13158	-2.060	0.04018 *
WTI CrudePL.dl1	0.08830	0.04496	1.964	0.05041 .
NGLLRGQL.dl1	0.24309	0.16976	1.432	0.15312
EthaEhtyStockQL.dl1	0.06025	0.13952	0.432	0.66615
GDPGOODSCAPL.dl1	-0.40069	0.28420	-1.410	0.15953
Monthly.PopL.dl1	81.03915	40.63345	1.994	0.04695 *
GasCityGatePL.dl1	-0.04275	0.04641	-0.921	0.35764
EthaEhtySupQL.dl2	-0.04686	0.08900	-0.526	0.59892
WTI CrudePL.dl2	0.01221	0.04783	0.255	0.79872
NGLLRGQL.dl2	-0.02667	0.12098	-0.220	0.82564
EthaEhtyStockQL.dl2	0.02810	0.12759	0.220	0.82585
GDPGOODSCAPL.dl2	-0.00921	0.27864	-0.033	0.97365
Monthly.PopL.dl2	-143.35660	40.36516	-3.551	0.00044 ***
GasCityGatePL.dl2	-0.05317	0.04549	-1.169	0.24329
EthaEhtySupQL.l3	-0.14239	0.08795	-1.619	0.10641
WTI CrudePL.l3	0.01510	0.01379	1.095	0.27440
NGLLRGQL.l3	0.16140	0.08803	1.834	0.06764 .
EthaEhtyStockQL.l3	-0.14605	0.02703	-5.404	1.27e-07 ***
GDPGOODSCAPL.l3	0.13231	0.09736	1.359	0.17511
Monthly.PopL.l3	-0.20578	0.43096	-0.477	0.63334
GasCityGatePL.l3	-0.06144	0.02757	-2.229	0.02653 *
constant	4.01750	7.38369	0.544	0.58675

---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.0601 on 323 degrees of freedom  
Multiple R-squared: 0.3126, Adjusted R-squared: 0.2658  
F-statistic: 6.678 on 22 and 323 DF, p-value: 2.425e-16

Response GDPGOODSCAPL.d :

Call:

```

lm(formula = GDPGOODSCAPL.d ~ EthaEhtySupQL.dl1 + WTI CrudePL.dl1 +
  NGLLRGQL.dl1 + EthaEhtyStockQL.dl1 + GDPGOODSCAPL.dl1 + Monthly.PopL.d
l1 +
  GasCityGatePL.dl1 + EthaEhtySupQL.dl2 + WTI CrudePL.dl2 +
  NGLLRGQL.dl2 + EthaEhtyStockQL.dl2 + GDPGOODSCAPL.dl2 + Monthly.PopL.d
l2 +

```

GasCityGatePL.dl2 + EthaEthySupQL.l3 + WTI CrudePL.l3 + NGLLRGQL.l3 +  
 EthaEhtyStockQL.l3 + GDPGOODSCAPL.l3 + Monthly.PopL.l3 +  
 GasCityGatePL.l3 + constant - 1, data = data.mat)

Residuals:

Min	1Q	Median	3Q	Max
-0.054553	-0.005790	0.000154	0.006870	0.040389

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
EthaEthySupQL.dl1	-0.0071928	0.0267594	-0.269	0.7883
WTICrudePL.dl1	0.0652137	0.0091441	7.132	6.53e-12 ***
NGLLRGQL.dl1	0.0018796	0.0345228	0.054	0.9566
EthaEhtyStockQL.dl1	-0.0285004	0.0283723	-1.005	0.3159
GDPGOODSCAPL.dl1	-0.2854922	0.0577951	-4.940	1.26e-06 ***
Monthly.PopL.dl1	3.0856590	8.2633573	0.373	0.7091
GasCityGatePL.dl1	0.0080288	0.0094384	0.851	0.3956
EthaEthySupQL.dl2	0.0277804	0.0180990	1.535	0.1258
WTICrudePL.dl2	0.0120256	0.0097262	1.236	0.2172
NGLLRGQL.dl2	-0.0204032	0.0246026	-0.829	0.4075
EthaEhtyStockQL.dl2	0.0213882	0.0259482	0.824	0.4104
GDPGOODSCAPL.dl2	-0.1412242	0.0566657	-2.492	0.0132 *
Monthly.PopL.dl2	-5.7585259	8.2087968	-0.702	0.4835
GasCityGatePL.dl2	0.0177034	0.0092510	1.914	0.0565 .
EthaEthySupQL.l3	0.0160647	0.0178850	0.898	0.3697
WTICrudePL.l3	-0.0006025	0.0028043	-0.215	0.8300
NGLLRGQL.l3	-0.0061786	0.0179015	-0.345	0.7302
EthaEhtyStockQL.l3	0.0013266	0.0054961	0.241	0.8094
GDPGOODSCAPL.l3	-0.0459293	0.0197990	-2.320	0.0210 *
Monthly.PopL.l3	0.1345287	0.0876406	1.535	0.1258
GasCityGatePL.l3	0.0024852	0.0056067	0.443	0.6579
constant	-2.3048749	1.5015729	-1.535	0.1258

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.01222 on 323 degrees of freedom  
 Multiple R-squared: 0.2839, Adjusted R-squared: 0.2352  
 F-statistic: 5.822 on 22 and 323 DF, p-value: 7.014e-14

Response Monthly.PopL.d :

Call:

```
lm(formula = Monthly.PopL.d ~ EthaEthySupQL.dl1 + WTI CrudePL.dl1 +
  NGLLRGQL.dl1 + EthaEhtyStockQL.dl1 + GDPGOODSCAPL.dl1 + Monthly.PopL.d
  dl1 +
  GasCityGatePL.dl1 + EthaEthySupQL.dl2 + WTI CrudePL.dl2 +
  NGLLRGQL.dl2 + EthaEhtyStockQL.dl2 + GDPGOODSCAPL.dl2 + Monthly.PopL.d
  dl2 +
  GasCityGatePL.dl2 + EthaEthySupQL.l3 + WTI CrudePL.l3 + NGLLRGQL.l3 +
  EthaEhtyStockQL.l3 + GDPGOODSCAPL.l3 + Monthly.PopL.l3 +
  GasCityGatePL.l3 + constant - 1, data = data.mat)
```

Residuals:

Min	1Q	Median	3Q	Max
-2.410e-04	-5.177e-05	5.260e-06	4.873e-05	3.513e-04

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
EthaEthySupQL.dl1	-2.808e-04	1.820e-04	-1.543	0.12376
WTICrudePL.dl1	2.341e-05	6.218e-05	0.376	0.70680
NGLLRGQL.dl1	4.416e-04	2.348e-04	1.881	0.06090 .
EthaEhtyStockQL.dl1	-1.053e-04	1.930e-04	-0.546	0.58562
GDPGOODSCAPL.dl1	7.243e-04	3.930e-04	1.843	0.06627 .
Monthly.PopL.dl1	8.276e-01	5.620e-02	14.727	< 2e-16 ***
GasCityGatePL.dl1	-5.157e-05	6.419e-05	-0.803	0.42229
EthaEthySupQL.dl2	-1.363e-04	1.231e-04	-1.107	0.26891
WTICrudePL.dl2	-2.358e-05	6.614e-05	-0.356	0.72173
NGLLRGQL.dl2	-8.228e-05	1.673e-04	-0.492	0.62320
EthaEhtyStockQL.dl2	1.604e-04	1.765e-04	0.909	0.36408

GDPGOODSCAPL. dl 2	1.314e-04	3.854e-04	0.341	0.73324
Monthly. PopL. dl 2	-5.772e-02	5.582e-02	-1.034	0.30195
GasCityGatePL. dl 2	-1.357e-04	6.291e-05	-2.157	0.03178 *
EthaEthySupQL. l3	-1.729e-04	1.216e-04	-1.421	0.15615
WTICrudePL. l3	-2.792e-05	1.907e-05	-1.464	0.14417
NGLLRQL. l3	6.726e-05	1.217e-04	0.552	0.58100
EthaEhtyStockQL. l3	-6.264e-05	3.738e-05	-1.676	0.09471 .
GDPGOODSCAPL. l3	4.387e-04	1.346e-04	3.258	0.00124 **
Monthly. PopL. l3	-1.287e-03	5.960e-04	-2.159	0.03161 *
GasCityGatePL. l3	-6.583e-05	3.813e-05	-1.727	0.08521 .
constant	2.309e-02	1.021e-02	2.261	0.02443 *

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 8.312e-05 on 323 degrees of freedom  
Multiple R-squared: 0.9913, Adjusted R-squared: 0.9907  
F-statistic: 1670 on 22 and 323 DF, p-value: < 2.2e-16

Response GasCityGatePL. d :

Call:

```
lm(formula = GasCityGatePL. d ~ EthaEthySupQL. dl 1 + WTICrudePL. dl 1 +
  NGLLRQL. dl 1 + EthaEhtyStockQL. dl 1 + GDPGOODSCAPL. dl 1 + Monthly. PopL. d
  l1 +
  GasCityGatePL. dl 1 + EthaEthySupQL. dl 2 + WTICrudePL. dl 2 +
  NGLLRQL. dl 2 + EthaEhtyStockQL. dl 2 + GDPGOODSCAPL. dl 2 + Monthly. PopL. d
  l2 +
  GasCityGatePL. dl 2 + EthaEthySupQL. l3 + WTICrudePL. l3 + NGLLRQL. l3 +
  EthaEhtyStockQL. l3 + GDPGOODSCAPL. l3 + Monthly. PopL. l3 +
  GasCityGatePL. l3 + constant - 1, data = data.mat)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.32805	-0.03408	0.00122	0.03470	0.30019

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
EthaEthySupQL. dl 1	-9.092e-02	1.679e-01	-0.541	0.588595
WTICrudePL. dl 1	1.437e-01	5.738e-02	2.504	0.012781 *
NGLLRQL. dl 1	2.854e-03	2.166e-01	0.013	0.989496
EthaEhtyStockQL. dl 1	-1.782e-01	1.781e-01	-1.001	0.317703
GDPGOODSCAPL. dl 1	-3.682e-01	3.627e-01	-1.015	0.310785
Monthly. PopL. dl 1	-1.190e+02	5.186e+01	-2.296	0.022342 *
GasCityGatePL. dl 1	-1.300e-02	5.923e-02	-0.220	0.826360
EthaEthySupQL. dl 2	4.243e-02	1.136e-01	0.374	0.708989
WTICrudePL. dl 2	7.356e-02	6.104e-02	1.205	0.229042
NGLLRQL. dl 2	-6.212e-02	1.544e-01	-0.402	0.687674
EthaEhtyStockQL. dl 2	1.695e-01	1.628e-01	1.041	0.298741
GDPGOODSCAPL. dl 2	-3.348e-01	3.556e-01	-0.942	0.347133
Monthly. PopL. dl 2	1.159e+02	5.151e+01	2.251	0.025088 *
GasCityGatePL. dl 2	-2.161e-01	5.806e-02	-3.722	0.000233 ***
EthaEthySupQL. l3	4.084e-02	1.122e-01	0.364	0.716228
WTICrudePL. l3	2.514e-02	1.760e-02	1.429	0.154067
NGLLRQL. l3	-1.186e-01	1.123e-01	-1.056	0.291944
EthaEhtyStockQL. l3	-2.784e-02	3.449e-02	-0.807	0.420102
GDPGOODSCAPL. l3	1.550e-01	1.242e-01	1.247	0.213235
Monthly. PopL. l3	-3.795e-01	5.500e-01	-0.690	0.490723
GasCityGatePL. l3	-9.829e-02	3.519e-02	-2.793	0.005525 **
constant	7.223e+00	9.423e+00	0.767	0.443903

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.0767 on 323 degrees of freedom  
Multiple R-squared: 0.1223, Adjusted R-squared: 0.06255  
F-statistic: 2.046 on 22 and 323 DF, p-value: 0.004177





**Table 3**  
**OLS equations from the restricted VECM**

Response EthaEthySupQL.d :

Call:

```
lm(formula = EthaEthySupQL.d ~ ect1 + ect2 + ect3 + EthaEthySupQL.dl1 +
  WTI CrudePL.dl1 + NGLLRGQL.dl1 + EthaEthyStockQL.dl1 + GDPGOODSCAPL.dl1 +
  Monthly.PopL.dl1 + GasCityGatePL.dl1 + EthaEthySupQL.dl2 +
  WTI CrudePL.dl2 + NGLLRGQL.dl2 + EthaEthyStockQL.dl2 + GDPGOODSCAPL.dl2 +
  Monthly.PopL.dl2 + GasCityGatePL.dl2 - 1, data = data.mat)
```

Residuals:

	Min	1Q	Median	3Q	Max
	-0.45601	-0.04528	0.00321	0.04948	0.19198

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
ect1	-0.366441	0.104289	-3.514	0.000504 ***
ect2	-0.005552	0.009606	-0.578	0.563694 .
ect3	0.125930	0.050421	2.498	0.012994 *
EthaEthySupQL.dl1	-0.005707	0.176482	-0.032	0.974224 .
WTI CrudePL.dl1	0.050245	0.060102	0.836	0.403769 .
<b>NGLLRGQL.dl1</b>	<b>-0.738282</b>	<b>0.225716</b>	<b>-3.271</b>	<b>0.001186 **</b>
<b>EthaEthyStockQL.dl1</b>	<b>0.616295</b>	<b>0.186190</b>	<b>3.310</b>	<b>0.001037 **</b>
GDPGOODSCAPL.dl1	0.510556	0.377206	1.354	0.176821 .
Monthly.PopL.dl1	-87.770758	54.706519	-1.604	0.109590 .
GasCityGatePL.dl1	-0.075173	0.061757	-1.217	0.224385 .
<b>EthaEthySupQL.dl2</b>	<b>-0.447094</b>	<b>0.109057</b>	<b>-4.100</b>	<b>5.22e-05 ***</b>
WTI CrudePL.dl2	0.035559	0.063638	0.559	0.576697 .
NGLLRGQL.dl2	0.158366	0.139486	1.135	0.257056 .
<b>EthaEthyStockQL.dl2</b>	<b>-0.296324</b>	<b>0.167571</b>	<b>-1.768</b>	<b>0.077932 .</b>
GDPGOODSCAPL.dl2	-0.167618	0.366529	-0.457	0.647749 .
<b>Monthly.PopL.dl2</b>	<b>184.407454</b>	<b>54.118174</b>	<b>3.407</b>	<b>0.000737 ***</b>
GasCityGatePL.dl2	0.007423	0.060372	0.123	0.902222 .

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.08129 on 328 degrees of freedom

Multiple R-squared: 0.3565, Adjusted R-squared: 0.3231

F-statistic: 10.69 on 17 and 328 DF, p-value: < 2.2e-16

Response WTI CrudePL.d :

Call:

```
lm(formula = WTI CrudePL.d ~ ect1 + ect2 + ect3 + EthaEthySupQL.dl1 +
  WTI CrudePL.dl1 + NGLLRGQL.dl1 + EthaEthyStockQL.dl1 + GDPGOODSCAPL.dl1 +
  Monthly.PopL.dl1 + GasCityGatePL.dl1 + EthaEthySupQL.dl2 +
  WTI CrudePL.dl2 + NGLLRGQL.dl2 + EthaEthyStockQL.dl2 + GDPGOODSCAPL.dl2 +
  Monthly.PopL.dl2 + GasCityGatePL.dl2 - 1, data = data.mat)
```

Residuals:

	Min	1Q	Median	3Q	Max
	-0.26971	-0.05055	0.00218	0.04896	0.36275

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
ect1	1.480e-02	1.034e-01	0.143	0.8862 .
ect2	-1.832e-02	9.520e-03	-1.924	0.0552 .
ect3	-3.001e-02	4.997e-02	-0.601	0.5485 .
EthaEthySupQL.dl1	-1.136e-01	1.749e-01	-0.649	0.5166 .
WTI CrudePL.dl1	2.376e-01	5.956e-02	3.989	8.17e-05 ***
NGLLRGQL.dl1	5.291e-02	2.237e-01	0.237	0.8132 .
EthaEthyStockQL.dl1	-2.580e-01	1.845e-01	-1.398	0.1630 .
GDPGOODSCAPL.dl1	1.557e-01	3.738e-01	0.416	0.6774 .
Monthly.PopL.dl1	-1.560e+01	5.422e+01	-0.288	0.7737 .
GasCityGatePL.dl1	-3.185e-02	6.120e-02	-0.520	0.6032 .

EthaEthySupQL. dl 2	1.201e-02	1.081e-01	0.111	0.9116
WTICrudePL. dl 2	9.860e-05	6.307e-02	0.002	0.9988
NGLLRGQL. dl 2	-7.947e-02	1.382e-01	-0.575	0.5657
EthaEhtyStockQL. dl 2	1.591e-01	1.661e-01	0.958	0.3388
GDPGOODSCAPL. dl 2	-6.778e-03	3.632e-01	-0.019	0.9851
Monthly. PopL. dl 2	-4.535e+01	5.363e+01	-0.846	0.3984
GasCityGatePL. dl 2	5.352e-03	5.983e-02	0.089	0.9288

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.08057 on 328 degrees of freedom  
Multiple R-squared: 0.1046, Adjusted R-squared: 0.05824  
F-statistic: 2.255 on 17 and 328 DF, p-value: 0.003289

Response NGLLRGQL. d :

Call:

```
lm(formula = NGLLRGQL.d ~ ect1 + ect2 + ect3 + EthaEthySupQL.dl1 +
  WTICrudePL.dl1 + NGLLRGQL.dl1 + EthaEhtyStockQL.dl1 + GDPGOODSCAPL.dl1 +
  Monthly.PopL.dl1 + GasCityGatePL.dl1 + EthaEthySupQL.dl2 +
  WTICrudePL.dl2 + NGLLRGQL.dl2 + EthaEhtyStockQL.dl2 + GDPGOODSCAPL.dl2 +
  Monthly.PopL.dl2 + GasCityGatePL.dl2 - 1, data = data.mat)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.225983	-0.021158	0.009363	0.028961	0.138882

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )	
ect1	-0.261749	0.060281	-4.342	1.88e-05	***
ect2	0.006609	0.005552	1.190	0.23478	
ect3	0.117886	0.029144	4.045	6.53e-05	***
EthaEthySupQL. dl 1	0.072775	0.102011	0.713	0.47610	
WTICrudePL. dl 1	0.068997	0.034740	1.986	0.04786	*
NGLLRGQL. dl 1	-0.788334	0.130470	-6.042	4.12e-09	***
EthaEhtyStockQL. dl 1	0.102695	0.107622	0.954	0.34068	
GDPGOODSCAPL. dl 1	0.129391	0.218035	0.593	0.55330	
Monthly. PopL. dl 1	-14.973228	31.621742	-0.474	0.63616	
GasCityGatePL. dl 1	-0.104635	0.035697	-2.931	0.00361	**
EthaEthySupQL. dl 2	-0.206532	0.063038	-3.276	0.00116	**
WTICrudePL. dl 2	0.073511	0.036784	1.998	0.04650	*
NGLLRGQL. dl 2	-0.046847	0.080627	-0.581	0.56162	
EthaEhtyStockQL. dl 2	-0.313717	0.096860	-3.239	0.00132	**
GDPGOODSCAPL. dl 2	-0.203659	0.211863	-0.961	0.33712	
Monthly. PopL. dl 2	-0.296002	31.281664	-0.009	0.99246	
GasCityGatePL. dl 2	-0.043911	0.034896	-1.258	0.20917	

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.04699 on 328 degrees of freedom  
Multiple R-squared: 0.3645, Adjusted R-squared: 0.3316  
F-statistic: 11.07 on 17 and 328 DF, p-value: < 2.2e-16

Response EthaEhtyStockQL. d :

Call:

```
lm(formula = EthaEhtyStockQL.d ~ ect1 + ect2 + ect3 + EthaEthySupQL.dl1 +
  WTICrudePL.dl1 + NGLLRGQL.dl1 + EthaEhtyStockQL.dl1 + GDPGOODSCAPL.dl1 +
  Monthly.PopL.dl1 + GasCityGatePL.dl1 + EthaEthySupQL.dl2 +
  WTICrudePL.dl2 + NGLLRGQL.dl2 + EthaEhtyStockQL.dl2 + GDPGOODSCAPL.dl2 +
  Monthly.PopL.dl2 + GasCityGatePL.dl2 - 1, data = data.mat)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.20197	-0.03570	-0.00026	0.03592	0.19190

Coefficients:

Estimate	Std. Error	t value	Pr(> t )
----------	------------	---------	----------

```

ect1          -1.075e-01  7.702e-02  -1.396  0.163717
ect2          2.137e-02  7.094e-03   3.013  0.002790 **
ect3          8.836e-02  3.724e-02   2.373  0.018216 *
EthaEthySupQL.dl1  -2.450e-01  1.303e-01  -1.879  0.061063 .
WTICrudePL.dl1   9.153e-02  4.439e-02   2.062  0.039973 *
NGLLRGQL.dl1    1.979e-01  1.667e-01   1.187  0.235925
EthaEhtyStockQL.dl1  9.948e-02  1.375e-01   0.723  0.469913
GDPGOODSCAPL.dl1 -3.612e-01  2.786e-01  -1.297  0.195693
Monthly.PopL.dl1  7.860e+01  4.040e+01   1.945  0.052583 .
GasCityGatePL.dl1 -5.728e-02  4.561e-02  -1.256  0.210014
EthaEthySupQL.dl2  -2.068e-02  8.054e-02  -0.257  0.797497
WTICrudePL.dl2   9.701e-03  4.700e-02   0.206  0.836598
NGLLRGQL.dl2    -8.495e-02  1.030e-01  -0.825  0.410181
EthaEhtyStockQL.dl2  4.080e-02  1.238e-01   0.330  0.741858
GDPGOODSCAPL.dl2  4.292e-02  2.707e-01   0.159  0.874126
Monthly.PopL.dl2  -1.535e+02  3.997e+01  -3.839  0.000148 ***
GasCityGatePL.dl2 -6.955e-02  4.458e-02  -1.560  0.119729

```

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.06004 on 328 degrees of freedom  
Multiple R-squared: 0.3036, Adjusted R-squared: 0.2675  
F-statistic: 8.41 on 17 and 328 DF, p-value: < 2.2e-16

Response GDPGOODSCAPL.d :

Call:

```
lm(formula = GDPGOODSCAPL.d ~ ect1 + ect2 + ect3 + EthaEthySupQL.dl1 +
  WTICrudePL.dl1 + NGLLRGQL.dl1 + EthaEhtyStockQL.dl1 + GDPGOODSCAPL.dl1 +
  Monthly.PopL.dl1 + GasCityGatePL.dl1 + EthaEthySupQL.dl2 +
  WTICrudePL.dl2 + NGLLRGQL.dl2 + EthaEhtyStockQL.dl2 + GDPGOODSCAPL.dl2 +
  Monthly.PopL.dl2 + GasCityGatePL.dl2 - 1, data = data.mat)
```

Residuals:

```

      Min       1Q   Median       3Q      Max
-0.056692 -0.006301  0.000235  0.007021  0.041035

```

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
ect1	0.021084	0.015848	1.330	0.1843
ect2	-0.003219	0.001460	-2.205	0.0282 *
ect3	-0.012672	0.007662	-1.654	0.0991 .
EthaEthySupQL.dl1	-0.003186	0.026819	-0.119	0.9055
WTICrudePL.dl1	0.064891	0.009133	7.105	7.54e-12 ***
NGLLRGQL.dl1	-0.001727	0.034301	-0.050	0.9599
EthaEhtyStockQL.dl1	-0.022634	0.028294	-0.800	0.4243
GDPGOODSCAPL.dl1	-0.248997	0.057322	-4.344	1.87e-05 ***
Monthly.PopL.dl1	1.512072	8.313430	0.182	0.8558
GasCityGatePL.dl1	0.008797	0.009385	0.937	0.3493
EthaEthySupQL.dl2	0.032946	0.016573	1.988	0.0476 *
WTICrudePL.dl2	0.007922	0.009671	0.819	0.4133
NGLLRGQL.dl2	-0.025498	0.021197	-1.203	0.2299
EthaEhtyStockQL.dl2	0.025023	0.025465	0.983	0.3265
GDPGOODSCAPL.dl2	-0.097534	0.055699	-1.751	0.0809 .
Monthly.PopL.dl2	-7.378395	8.224023	-0.897	0.3703
GasCityGatePL.dl2	0.017739	0.009174	1.934	0.0540 .

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.01235 on 328 degrees of freedom  
Multiple R-squared: 0.2572, Adjusted R-squared: 0.2187  
F-statistic: 6.68 on 17 and 328 DF, p-value: 1.019e-13

Response Monthly.PopL.d :

Call:

```
lm(formula = Monthly.PopL.d ~ ect1 + ect2 + ect3 + EthaEthySupQL.dl1 +
  WTICrudePL.dl1 + NGLLRGQL.dl1 + EthaEhtyStockQL.dl1 + GDPGOODSCAPL.dl1 +
```

Monthl y. PopL. dl 1 + GasCi tyGatePL. dl 1 + EthaEthySupQL. dl 2 +  
 WTI CrudePL. dl 2 + NGLLRGQL. dl 2 + EthaEhtyStockQL. dl 2 + GDPGOODSCAPL. dl 2 +  
 Monthl y. PopL. dl 2 + GasCi tyGatePL. dl 2 - 1, data = data. mat)

Resi dual s:

	Min	1Q	Medi an	3Q	Max
	-2. 395e-04	-5. 201e-05	2. 610e-06	4. 914e-05	3. 700e-04

Coeffi ci ents:

	Estimate	Std. Error	t value	Pr(> t )
ect1	-1. 659e-04	1. 062e-04	-1. 563	0. 1191
ect2	-2. 300e-05	9. 778e-06	-2. 352	0. 0192 *
ect3	5. 092e-05	5. 132e-05	0. 992	0. 3218
EthaEthySupQL. dl 1	-2. 833e-04	1. 796e-04	-1. 577	0. 1158
WTI CrudePL. dl 1	1. 882e-05	6. 118e-05	0. 308	0. 7585
NGLLRGQL. dl 1	4. 366e-04	2. 298e-04	1. 900	0. 0583 .
EthaEhtyStockQL. dl 1	-1. 137e-04	1. 895e-04	-0. 600	0. 5491
GDPGOODSCAPL. dl 1	6. 524e-04	3. 840e-04	1. 699	0. 0903 .
Monthl y. PopL. dl 1	8. 348e-01	5. 568e-02	14. 991	<2e-16 ***
GasCi tyGatePL. dl 1	-5. 190e-05	6. 286e-05	-0. 826	0. 4096
EthaEthySupQL. dl 2	-1. 287e-04	1. 110e-04	-1. 159	0. 2472
WTI CrudePL. dl 2	-1. 885e-05	6. 478e-05	-0. 291	0. 7713
NGLLRGQL. dl 2	-1. 025e-04	1. 420e-04	-0. 722	0. 4707
EthaEhtyStockQL. dl 2	1. 633e-04	1. 706e-04	0. 957	0. 3391
GDPGOODSCAPL. dl 2	3. 266e-05	3. 731e-04	0. 088	0. 9303
Monthl y. PopL. dl 2	-5. 450e-02	5. 509e-02	-0. 989	0. 3232
GasCi tyGatePL. dl 2	-1. 345e-04	6. 145e-05	-2. 188	0. 0293 *

---

Si gni f. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 8.275e-05 on 328 degrees of freedom

Multiple R-squared: 0.9912, Adjusted R-squared: 0.9908

F-statistic: 2180 on 17 and 328 DF, p-value: < 2.2e-16

Response GasCi tyGatePL. d :

Call:

lm(formula = GasCi tyGatePL. d ~ ect1 + ect2 + ect3 + EthaEthySupQL. dl 1 +  
 WTI CrudePL. dl 1 + NGLLRGQL. dl 1 + EthaEhtyStockQL. dl 1 + GDPGOODSCAPL. dl 1 +  
 Monthl y. PopL. dl 1 + GasCi tyGatePL. dl 1 + EthaEthySupQL. dl 2 +  
 WTI CrudePL. dl 2 + NGLLRGQL. dl 2 + EthaEhtyStockQL. dl 2 + GDPGOODSCAPL. dl 2 +  
 Monthl y. PopL. dl 2 + GasCi tyGatePL. dl 2 - 1, data = data. mat)

Resi dual s:

	Min	1Q	Medi an	3Q	Max
	-0. 33342	-0. 03644	-0. 00113	0. 03617	0. 28298

Coeffi ci ents:

	Estimate	Std. Error	t value	Pr(> t )
ect1	-0. 05348	0. 09890	-0. 541	0. 58908
ect2	0. 01939	0. 00911	2. 129	0. 03400 *
ect3	0. 05396	0. 04782	1. 128	0. 25994
EthaEthySupQL. dl 1	-0. 12893	0. 16737	-0. 770	0. 44164
WTI CrudePL. dl 1	0. 14677	0. 05700	2. 575	0. 01046 *
NGLLRGQL. dl 1	0. 06910	0. 21406	0. 323	0. 74703
EthaEhtyStockQL. dl 1	-0. 23515	0. 17658	-1. 332	0. 18387
GDPGOODSCAPL. dl 1	-0. 41207	0. 35773	-1. 152	0. 25021
Monthl y. PopL. dl 1	-118. 56408	51. 88204	-2. 285	0. 02294 *
GasCi tyGatePL. dl 1	0. 01630	0. 05857	0. 278	0. 78096
EthaEthySupQL. dl 2	-0. 03473	0. 10343	-0. 336	0. 73727
WTI CrudePL. dl 2	0. 08067	0. 06035	1. 337	0. 18224
NGLLRGQL. dl 2	0. 07456	0. 13229	0. 564	0. 57340
EthaEhtyStockQL. dl 2	0. 11157	0. 15892	0. 702	0. 48313
GDPGOODSCAPL. dl 2	-0. 38806	0. 34760	-1. 116	0. 26508
Monthl y. PopL. dl 2	129. 43812	51. 32408	2. 522	0. 01214 *
GasCi tyGatePL. dl 2	-0. 18715	0. 05726	-3. 269	0. 00119 **

---

Si gni f. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.0771 on 328 degrees of freedom  
Multiple R-squared: 0.09962, Adjusted R-squared: 0.05295  
F-statistic: 2.135 on 17 and 328 DF, p-value: 0.005863

>