Summary Results – For each candidate

Cruz

```
resultscruz.test_causality('Cruz', ['Total', 'per_pos'], kind='f')

Granger causality f-test
========================================================
   Test statistic    Critical Value        p-value        df
--------------------------------------------------------
        1.744479           2.400220         0.140   (4, 316)
========================================================
H_0: ['Total', 'per_pos'] do not Granger-cause Cruz
Conclusion: fail to reject H_0 at 5.00% significance level

{'conclusion': 'fail to reject',
 'crit_value': 2.4002204693427718,
 'df': (4, 316),
 'pvalue': 0.13997258260147247,
 'signif': 0.05,
 'statistic': 1.7444792976312029}
```

```
resultscruz.test_causality('Total', ['Cruz'], kind='f')

Granger causality f-test
========================================================
   Test statistic    Critical Value        p-value        df
--------------------------------------------------------
        4.753898           3.024313         0.009   (2, 316)



========================================================
H_0: ['Cruz'] do not Granger-cause Total
Conclusion: reject H_0 at 5.00% significance level

{'conclusion': 'reject',
 'crit_value': 3.0243126564787883,
 'df': (2, 316),
 'pvalue': 0.0092439741192041954,
 'signif': 0.05,
 'statistic': 4.7538980045256842}
```

For Ted Cruz, it is the opposite of our hypothesis. Instead of news stories driving contributions, instead the model is better at predicting the total number of news stories. This implies the news lags the public in terms of popular opinion rather than the driving force behind it

Clinton

```
mclinton = smt.VAR(dclinton[1:])
mclinton.select_order(7)
```

```
                VAR Order Selection
==================================================
          aic          bic          fpe         hqic
--------------------------------------------------
0        21.05        21.17     1.385e+09        21.10
1        20.37        20.96*    7.030e+08        20.61*
2        20.28        21.34     6.422e+08        20.70
3        20.06        21.60     5.218e+08        20.68
4        20.03*       22.04     5.145e+08*       20.84
5        20.09        22.58     5.597e+08        21.09
6        20.12        23.07     5.937e+08        21.30
7        20.19        23.62     6.707e+08        21.57
==================================================
* Minimum
```

```
{'aic': 4, 'bic': 1, 'fpe': 4, 'hqic': 1}
```

```
## Choosing a lag of 1 or 4

resultsclinton = mclinton.fit(maxlags = 7, ic = 'fpe')
resultsclinton.summary()
```

```
  Summary of Regression Results
==================================
Model:                     VAR
Method:                    OLS
Date:          Mon, 09, May, 2016
Time:                 04:42:43
--------------------------------------------------------------
No. of Equations:       4.00000    BIC:                  21.9231
Nobs:                   84.0000    HQIC:                 20.7463
Log likelihood:        -1246.89    FPE:              4.74585e+08
AIC:                    19.9553    Det(Omega_mle):   2.27063e+08
--------------------------------------------------------------
```

	coefficient	std. error	t-stat	prob
const	4064.909320	17292.089742	0.235	0.815
L1.Clinton	-0.167639	0.121152	-1.384	0.17
L1.P	-40388.560764	63107.390083	-0.640	0.52
L1.Total	3461.123970	6222.433801	0.556	0.58
L1.per_pos	506418.984892	435146.796435	1.164	0.24
L2.Clinton	-0.208237	0.130833	-1.592	0.11
L2.P	-31090.904369	75874.181934	-0.410	0.68
L2.Total	-8095.535743	6636.109162	-1.220	0.22
L2.per_pos	450951.722770	546177.232841	0.826	0.41
L3.Clinton	-0.071085	0.131846	-0.539	0.59
L3.P	118590.110940	74333.872062	1.595	0.115
L3.Total	-13044.419367	6805.315027	-1.917	0.06
L3.per_pos	-158640.605456	549255.470357	-0.289	0.77
L4.Clinton	-0.296424	0.124961	-2.372	0.02
L4.P	8637.231418	62432.377315	0.138	0.890
L4.Total	-6045.499559	5827.659428	-1.037	0.30
L4.per_pos	-7709.700630	459104.981621	-0.017	0.98

Results for equation P
==
==

	coefficient	std. error	t-stat	prob
const	0.003760	0.075197	0.050	0.960
L1.Clinton	0.000001	0.000001	1.949	0.055
L1.P	−0.659111	0.274432	−2.402	0.019
L1.Total	−0.013618	0.027059	−0.503	0.616
L1.per_pos	0.269166	1.892298	0.142	0.887
L2.Clinton	0.000000	0.000001	0.256	0.798
L2.P	−0.427290	0.329950	−1.295	0.200
L2.Total	−0.029377	0.028858	−1.018	0.312
L2.per_pos	0.171877	2.375130	0.072	0.943
L3.Clinton	0.000000	0.000001	0.161	0.873
L3.P	−0.400852	0.323252	−1.240	0.219
L3.Total	0.005499	0.029594	0.186	0.853
L3.per_pos	0.570204	2.388516	0.239	0.812
L4.Clinton	0.000000	0.000001	0.719	0.474
L4.P	−0.130282	0.271496	−0.480	0.633
L4.Total	−0.026898	0.025342	−1.061	0.292
L4.per_pos	−0.666471	1.996484	−0.334	0.740

==

Results for equation Total
==
==

	coefficient	std. error	t-stat	prob
const	−0.025031	0.407556	−0.061	0.951
L1.Clinton	0.000011	0.000003	3.817	0.000
L1.P	1.376234	1.487373	0.925	0.358
L1.Total	−0.661482	0.146656	−4.510	0.000
L1.per_pos	1.213699	10.255940	0.118	0.906
L2.Clinton	0.000006	0.000003	2.056	0.044
L2.P	2.178406	1.788272	1.218	0.227
L2.Total	−0.740746	0.156406	−4.736	0.000
L2.per_pos	−16.454666	12.872807	−1.278	0.206
L3.Clinton	0.000006	0.000003	1.907	0.061
L3.P	3.624645	1.751969	2.069	0.042
L3.Total	−0.426945	0.160394	−2.662	0.010
L3.per_pos	−25.913087	12.945358	−2.002	0.049
L4.Clinton	−0.000000	0.000003	−0.034	0.973
L4.P	−0.077414	1.471464	−0.053	0.958
L4.Total	−0.216387	0.137352	−1.575	0.120
L4.per_pos	−2.394364	10.820608	−0.221	0.826

==

Results for equation per_pos
==
==

	coefficient	std. error	t-stat	prob
const	0.002431	0.010279	0.237	0.814
L1.Clinton	-0.000000	0.000000	-0.138	0.89
1				
L1.P	0.010230	0.037513	0.273	0.786
L1.Total	-0.001287	0.003699	-0.348	0.72
9				
L1.per_pos	-0.807379	0.258667	-3.121	0.00

3				
L2.Clinton	-0.000000	0.000000	-0.484	0.63
0				
L2.P	0.007150	0.045102	0.159	0.875
L2.Total	0.000875	0.003945	0.222	0.825
L2.per_pos	-0.447075	0.324668	-1.377	0.17
3				
L3.Clinton	-0.000000	0.000000	-0.752	0.45
5				
L3.P	-0.001220	0.044187	-0.028	0.978
L3.Total	0.002229	0.004045	0.551	0.583
L3.per_pos	-0.348224	0.326498	-1.067	0.29
0				
L4.Clinton	-0.000000	0.000000	-0.767	0.44
6				
L4.P	0.009494	0.037112	0.256	0.799
L4.Total	-0.002309	0.003464	-0.666	0.50
7				
L4.per_pos	-0.277330	0.272909	-1.016	0.31
3				

Correlation matrix of residuals

	Clinton	P	Total	per_pos
Clinton	1.000000	0.085579	0.221743	0.109256
P	0.085579	1.000000	0.369940	0.873489
Total	0.221743	0.369940	1.000000	0.134030
per_pos	0.109256	0.873489	0.134030	1.000000

```
Granger causality f-test
===================================================================
   Test statistic    Critical Value          p-value         df
-------------------------------------------------------------------
        1.038344          1.973040            0.407   (8, 268)
===================================================================
H_0: ['Total', 'per_pos'] do not Granger-cause Clinton
Conclusion: fail to reject H_0 at 5.00% significance level

{'conclusion': 'fail to reject',
 'crit_value': 1.9730397910233639,
 'df': (8, 268),
 'pvalue': 0.40739178754854383,
 'signif': 0.05,
 'statistic': 1.0383444236439043}
```

```
resultsclinton.test_causality('Total', ['Clinton'], kind='f')
```

```
Granger causality f-test
===================================================================
   Test statistic    Critical Value          p-value         df
-------------------------------------------------------------------
        4.736033          2.405327            0.001   (4, 268)
===================================================================
H_0: ['Clinton'] do not Granger-cause Total
Conclusion: reject H_0 at 5.00% significance level

{'conclusion': 'reject',
 'crit_value': 2.4053265949165259,
```

```
 'df': (4, 268),
 'pvalue': 0.0010435405664230568,
 'signif': 0.05,
 'statistic': 4.736032904980215}
```

Similar to Ted Cruz, Clinton shows the same dynamic of donations leading the number of news stories.

Sanders

```
# Sanders

msanders = smt.VAR(dsanders[1:])
msanders.select_order(7)
```

```
               VAR Order Selection
==========================================================
            aic          bic          fpe          hqic
----------------------------------------------------------
0         30.43        30.55      1.643e+13       30.48
1         29.58        30.16*     7.046e+12       29.82
2         29.41        30.45      5.923e+12       29.83
3         29.20*       30.70      4.840e+12*      29.80*
4         29.38        31.35      5.892e+12       30.17
5         29.47        31.90      6.592e+12       30.45
6         29.42        32.32      6.467e+12       30.59
7         29.58        32.93      7.884e+12       30.93
==========================================================
* Minimum


{'aic': 3, 'bic': 1, 'fpe': 3, 'hqic': 3}
```

```
## Choosing a lag of 3

resultssanders = msanders.fit(maxlags = 7, ic = 'fpe')
resultssanders.summary()
```

```
  Summary of Regression Results
===================================
Model:                        VAR
Method:                       OLS
Date:          Mon, 09, May, 2016
Time:                    04:44:35
--------------------------------------------------------------------
No. of Equations:       4.00000    BIC:                      30.5128
Nobs:                   88.0000    HQIC:                     29.6386
Log likelihood:         -1725.62   FPE:                  4.16442e+12
```

```
AIC:                      29.0489   Det(Omega_mle):      2.39994e+12
-----------------------------------------------------------------------
Results for equation Sanders
=======================================================================
==
                coefficient      std. error       t-stat           prob
-----------------------------------------------------------------------
-------
const           271558.037696   546891.328226     0.497           0.62
1
```

```
L1.Sanders        -0.798144        0.112364        -7.103          0.00
0
L1.P          -314337.360580   973942.785074       -0.323          0.74
8
L1.Total       -69497.384593   199463.776346       -0.348          0.72
9
L1.per_pos    4660298.578625  5772050.634805        0.807          0.42
2
L2.Sanders        -0.543306        0.147851        -3.675          0.00
0
L2.P           104487.200833  1024615.571770        0.102          0.91
9
L2.Total      -193916.460970   203695.534216       -0.952          0.34
4
L2.per_pos    -150355.544761  5454447.701450       -0.028          0.97
8
L3.Sanders        -0.263792        0.136122        -1.938          0.05
6
L3.P            95052.699256   812867.555027        0.117          0.907
L3.Total      -409868.786273   192155.951643       -2.133          0.03
6
L3.per_pos    1995593.065880  4285683.633367        0.466          0.64

=======================================================================
==

Results for equation P
=======================================================================
==
                coefficient      std. error       t-stat           prob
-----------------------------------------------------------------------
-------
const            0.002243         0.119976         0.019           0.985
L1.Sanders       0.000000         0.000000         1.465           0.147
L1.P            -0.608024         0.213662        -2.846           0.006
L1.Total        -0.018537         0.043758        -0.424           0.67
3
L1.per_pos      -0.952465         1.266264        -0.752           0.45
4
L2.Sanders       0.000000         0.000000         2.324           0.023
L2.P            -0.243837         0.224779        -1.085           0.281
L2.Total        -0.032694         0.044686        -0.732           0.46
7
L2.per_pos      -1.265244         1.196589        -1.057           0.29
4
L3.Sanders       0.000000         0.000000         1.516           0.134
L3.P            -0.150776         0.178326        -0.846           0.401
L3.Total        -0.065903         0.042155        -1.563           0.12
2
L3.per_pos      -1.522326         0.940187        -1.619           0.11
0
=======================================================================
==

Results for equation Total
=======================================================================
==
```

	coefficient	std. error	t-stat	prob
const	−0.014097	0.358193	−0.039	0.969
L1.Sanders	0.000000	0.000000	1.503	0.137
L1.P	−0.130457	0.637895	−0.205	0.839
L1.Total	−0.454505	0.130641	−3.479	0.001
L1.per_pos	1.420637	3.780474	0.376	0.708
L2.Sanders	0.000000	0.000000	0.517	0.606
L2.P	1.268776	0.671084	1.891	0.063
L2.Total	−0.507233	0.133413	−3.802	0.000
L2.per_pos	−5.152533	3.572456	−1.442	0.153
L3.Sanders	0.000000	0.000000	0.671	0.504
L3.P	0.869835	0.532397	1.634	0.106
L3.Total	−0.351087	0.125855	−2.790	0.007
L3.per_pos	−2.173439	2.806960	−0.774	0.441

===

Results for equation per_pos
===

	coefficient	std. error	t-stat	prob
const	−0.002087	0.018708	−0.112	0.911
L1.Sanders	0.000000	0.000000	1.164	0.248
L1.P	0.007091	0.033317	0.213	0.832
L1.Total	−0.006562	0.006823	−0.962	0.339
L1.per_pos	−0.826753	0.197453	−4.187	0.000
L2.Sanders	0.000000	0.000000	2.992	0.004
L2.P	−0.003632	0.035050	−0.104	0.918
L2.Total	−0.002246	0.006968	−0.322	0.748
L2.per_pos	−0.520935	0.186588	−2.792	0.007
L3.Sanders	0.000000	0.000000	1.456	0.150
L3.P	0.018401	0.027807	0.662	0.510
L3.Total	−0.007920	0.006573	−1.205	0.232
L3.per_pos	−0.464525	0.146606	−3.169	0.002

===

Correlation matrix of residuals

	Sanders	P	Total	per_pos
Sanders	1.000000	−0.048188	0.059271	−0.093986
P	−0.048188	1.000000	0.419527	0.813664
Total	0.059271	0.419527	1.000000	0.098355

| per_pos | −0.093986 | 0.813664 | 0.098355 | 1.000000 |

```
Granger causality f-test
=================================================================
   Test statistic    Critical Value            p-value            df
-----------------------------------------------------------------
        1.214552          2.128852               0.299    (6, 300)
=================================================================
H_0: ['Total', 'per_pos'] do not Granger-cause Sanders
Conclusion: fail to reject H_0 at 5.00% significance level

{'conclusion': 'fail to reject',
 'crit_value': 2.1288517519953429,
 'df': (6, 300),
 'pvalue': 0.29851918499322522,
 'signif': 0.05,
 'statistic': 1.2145519260945494}
```

```
resultssanders.test_causality('Total', ['Sanders'], kind='f')
```

```
Granger causality f-test
=================================================================
   Test statistic    Critical Value            p-value            df
-----------------------------------------------------------------
```

```
        0.849079          2.634701               0.468    (3, 300)
=================================================================
H_0: ['Sanders'] do not Granger-cause Total
Conclusion: fail to reject H_0 at 5.00% significance level

{'conclusion': 'fail to reject',
 'crit_value': 2.6347007871139292,
 'df': (3, 300),
 'pvalue': 0.46798002582658549,
 'signif': 0.05,
 'statistic': 0.84907919604610382}
```

Sanders does not have the same dynamic, the contributions do not push forward the news stories. This would support some of the supporters' earlier claims that Sanders, despite his popularity, is underrepresented in the media.

Final Summary:

None of the candidates supported my initial hypothesis of media quantity and sentiment driving campaign dollars (with the analysis at hand). Rather surprisingly, the opposite appeared to be true, with the amount of donations influencing the number of stories written about the candidates.

This would indicate that the popularity is not being driven by the media, but instead the media is being driven by the public zeitgeist and that popular opinion rather than reporting is driving the news (which I'm sure cynics would agree with).

For Clinton and Cruz, Clinton is more sensitive to this effect, which is consistent with her greater popularity and familiarity.

Sanders however, did not exhibit this effect. The reasoning could be because of the data itself: Sanders' campaign contributions, except for several step changes, were uniform and had steady growth. But another explanation could be the relative paucity of media coverage for the candidate despite his popularity, a complaint voiced by many of his supporters.