YES ENERGY

Measures of Convergence in Up To Congestion Markets

Dr. Scott Holladay
Senior Economist
Yes Energy

FERC Technical Conference on Financial Transactions in PJM
1/7/2014

Introduction

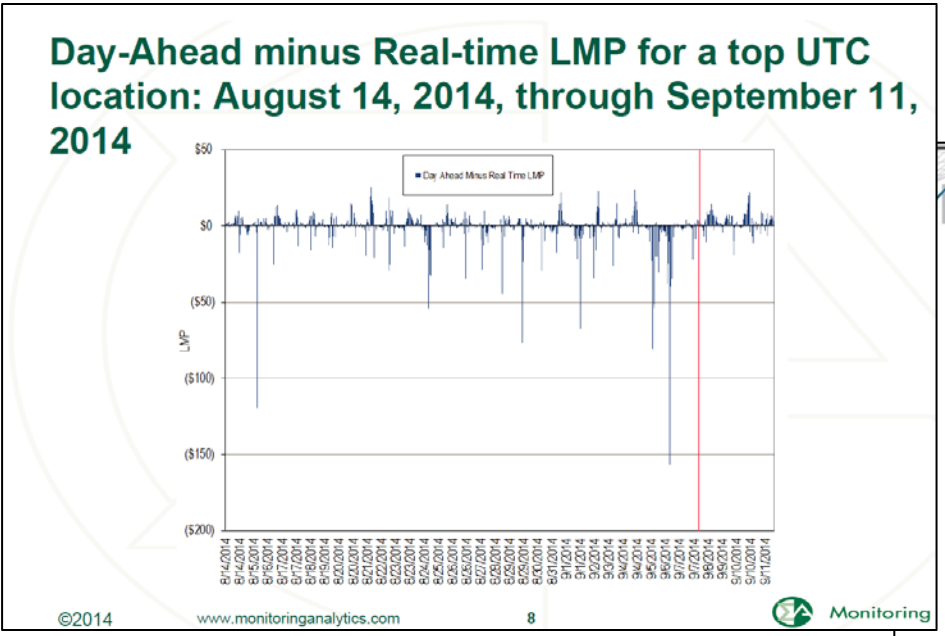
- About Me
  - Asst. Professor of Economics, University of Tennessee
  - PhD from University of Colorado, 2009
  - Founding partner at Yes Energy
- About Yes Energy and Why We're Here
  - Information/Analytics Provider specifically devoted to helping nodal markets function well through better analysis and more data
  - Diverse customer list includes: utilities, merchant generators, LSEs, banks, hedge funds, consultants, and more
  - We are NOT an advocacy organization for any particular set of our customers
  - This policy question is important - we DO advocate it be considered quantitatively based upon data

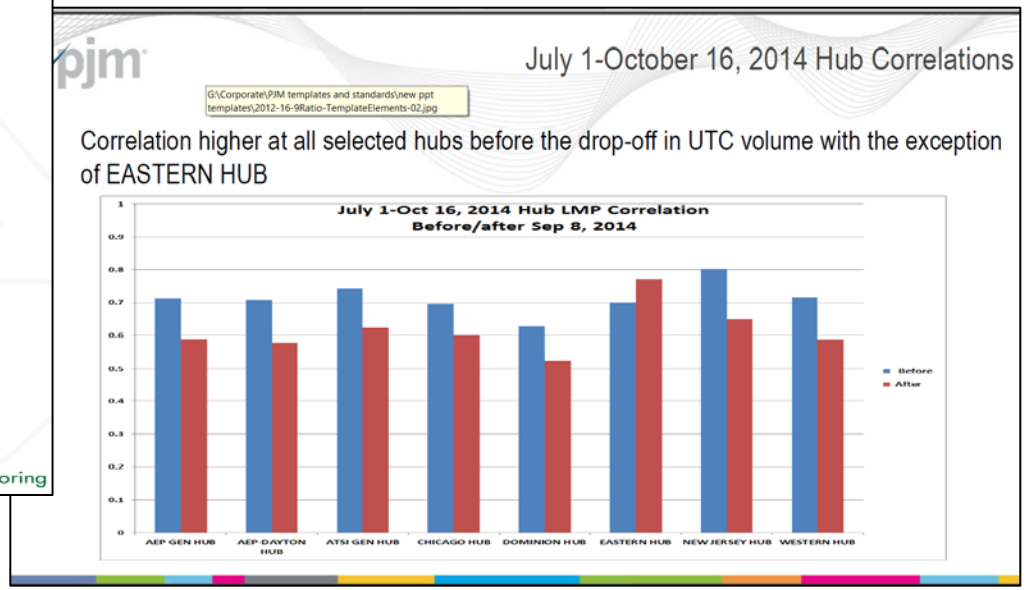
Background Facts From the Record

- The FERC Order indicates potential for changes in allocation of uplift fees
- Fees modify behavior of market participants
- Uncertainty about fees can act like a fee
- UTC volume plummeted, Inc/Dec perhaps increase slightly
- Trades were ‘more profitable’ for those still participating
- DA-RT Convergence is good & generally reduces uplift
- Almost all nodes are eligible as Incs/Decs, but only a small subset eligible for UTC

The FERC 206 Order and Market Convergence

- Background facts + public data + econometric methods = Our approach to measuring UTC impacts on convergence
- Early analysis: Reaction to the order caused *improved convergence*
- Our own simple regression analysis suggested a 21% improvement
- Others used "Before/After" methods and presented similar findings:

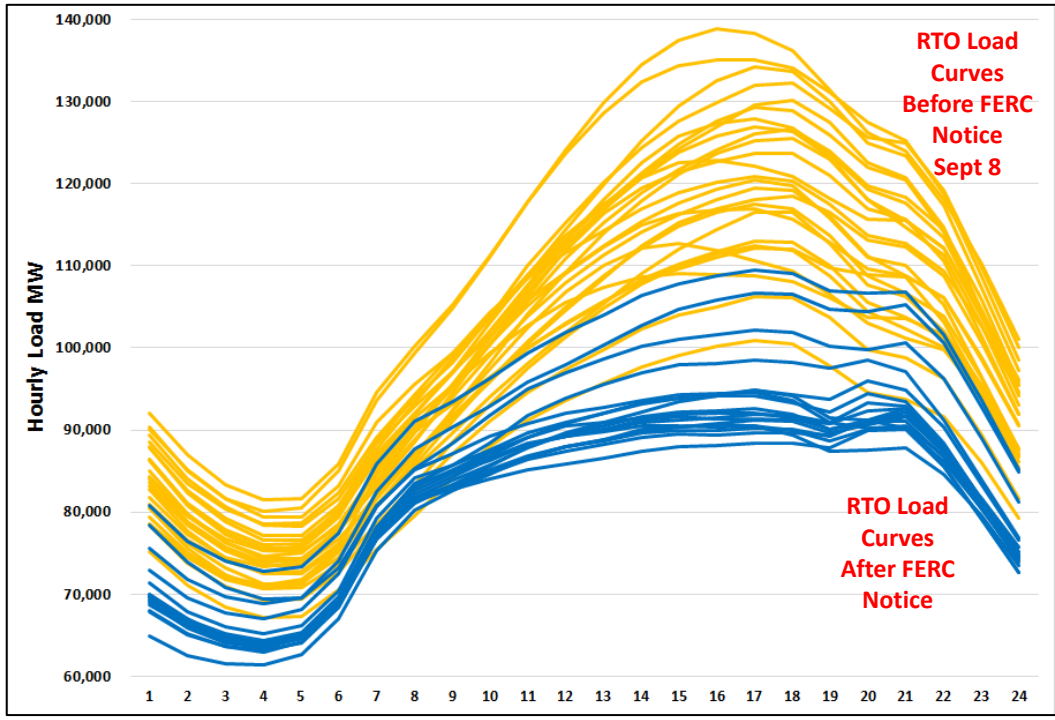




Before/After = Apples/Oranges

- Before/After is simple, intuitive, and incomplete
- Note: other factors beyond the word of FERC impact power markets
- Accounting for other factors is not easy, but necessary and doable

Comparing	Before	After
MidAtl Avg Load	35,903	29,264
MidAtl Peak Load	43,884	33,662
Avg Temp - Philly	76	67
Avg Daily Gen Outage MWs	453	24,304
# 345kV+ Trans Outages	224	403
Tetco M3 Gas $/MMBtu	$ 2.36	$ 1.97
Avg Abs DART Return	$ 7.88	$ 4.94



Difference-in-Difference ("Diff-in-Diff") Method

$$\underbrace{[DART_{POST} - DART_{PRE}]}_{2014} - \underbrace{[DART_{POST} - DART_{PRE}]}_{2013}$$

(or other years)

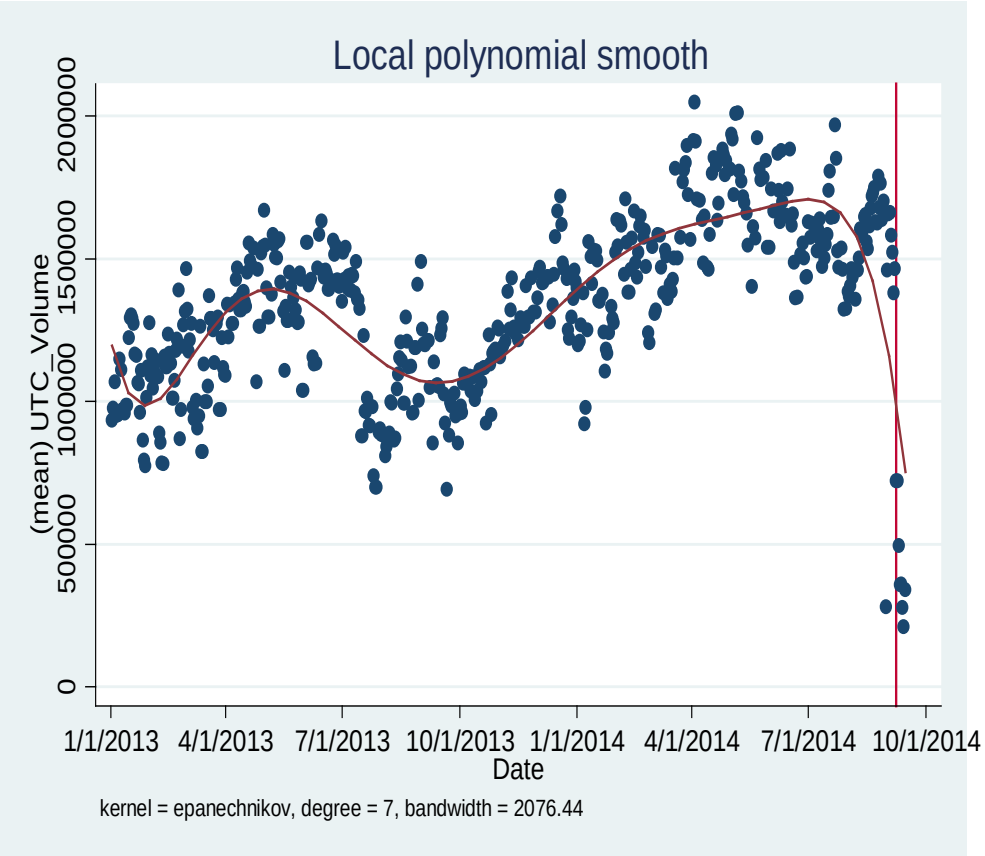
Key Questions:

- Is convergence better/worse, before/after *similar timeframes*
  - in other years?
  - when normalizing for key drivers?
- Is this convergence relationship the same for
  - all zones?
  - all PJM nodes or just the UTC eligible nodes?

Sample Model Results: Post-FERC Order → Drop in UTC Volume

- Diff-in-Diff produces expected results such as the fact that fees uncertainty reduced volume

UTC_Volume	Coef.	Newey-West Std. Err.	t
1.pre_post	-123787.4	65152.57	-1.90
1.year_2014	392595.7	61549.98	6.38
pre_post#year_2014			
1 1	-990200	102639.7	-9.65
_cons	1220481	55146.66	22.13



Diff-in-Diff: Post-FERC Order → Worse Convergence

Absolute Dart Return

	Model	Model w/ Controls
Post-Order	-1.657***	-0.751***
	(-28.99)	(-12.09)
2014	0.442***	0.839***
	(13.45)	(34.92)
Diff-in-Diff	0.147	1.520***
	(1.95)	(33.09)
Constant	7.536***	67.16***
	(364.75)	(93.26)
Observations	2,144,348	1,921,863

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Controls omitted for space

	Change in Convergence Pre-Post Order w/Controls
2013	**Convergence increased by $0.751/MWh**
2014	**Convergence decreased by $0.769/MWh**
Net Difference	**Convergence decreased by *$1.52/MWh***

Diff-in-Diff: Post-FERC Order → Higher OPRES

Operating Reserve Charges for RT Deviations

	Diff-in-Diff	UTC Volume
Post-Order	1.271***	
	(1785.46)	
2014	-0.709***	
	(-1466.00)	
Diff-in-Diff	0.0960***	
	(98.48)	
UTC Volume		-0.000000159***
		(-95.84)
Constant	8.401***	14.41***
	(677.68)	(421.58)
Observations	1,547,913	1,173,634
R^2	0.440	0.419

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Controls omitted for space

	Change in OPRES Pre-Post Order w/Controls
2013	**OPRES increased by $1.271/MWh**
2014	**OPRES decreased by $1.367/MWh**
Net Difference	**OPRES increased by *$0.10/MWh***

The Results are Robust

Results remain consistent across nearly 2 million observations and 10 different model specifications across 17 controls including:

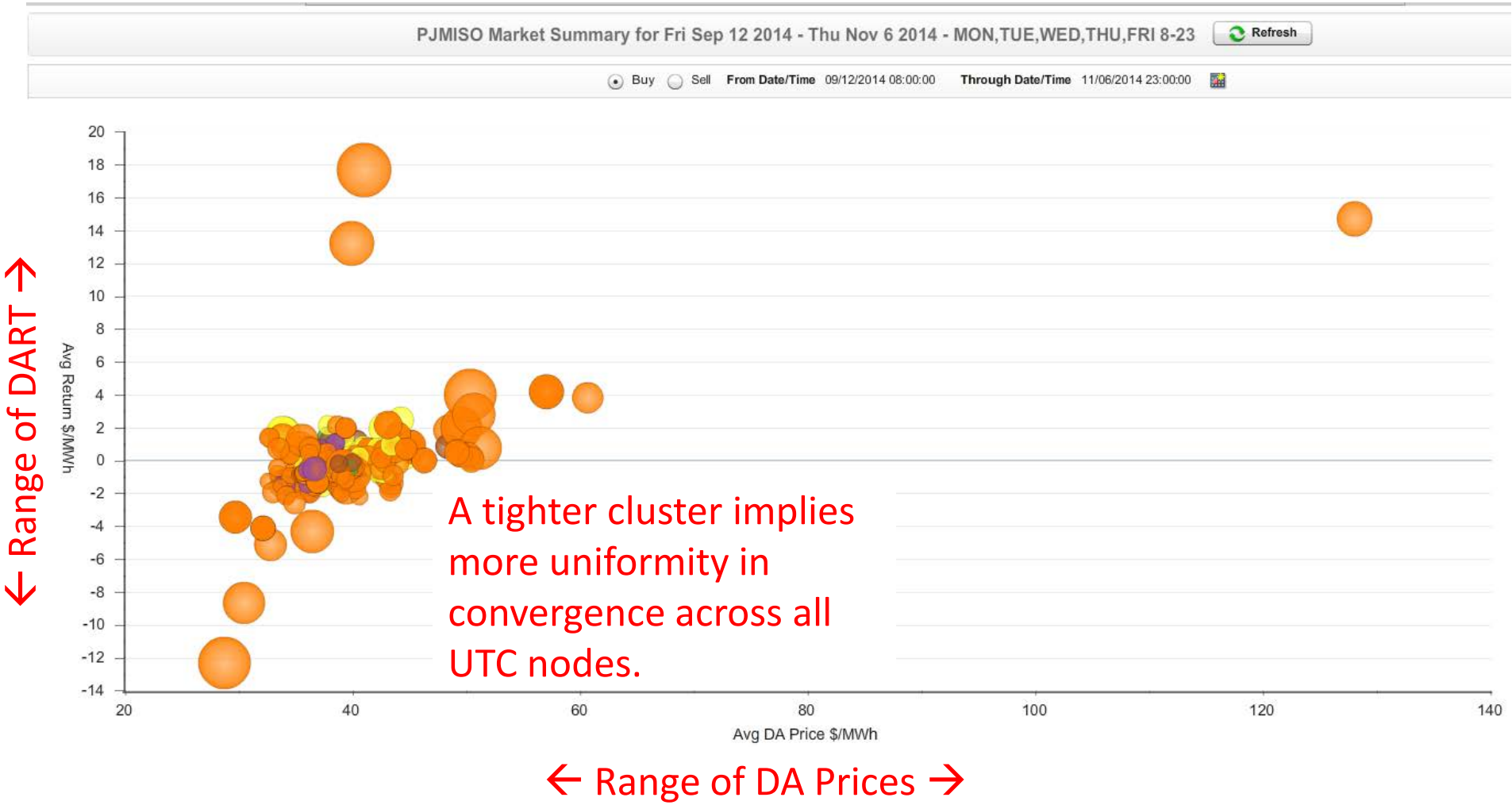
- UTC volume
- Post/pre order
- Year
- Gas price
- Maximum temperature
- Minimum temperature
- Average temperature
- Standard deviation of temperature
- Max load
- Max load squared
- Day of the week
- Month of the year

Conclusions

- Higher UTC Volume increases convergence
- Convergence is good and reduces uplift
- Some critical level of trading volume and participation is required to facilitate convergence
- “Before/After” analysis suggests the reaction to the FERC order improved convergence…
- But full analysis suggests the reaction to the FERC order (using Difference-in-Difference) has made convergence worse
- Similar methods also suggest the reaction to the FERC order also increased OPRES charges

Technical Appendix

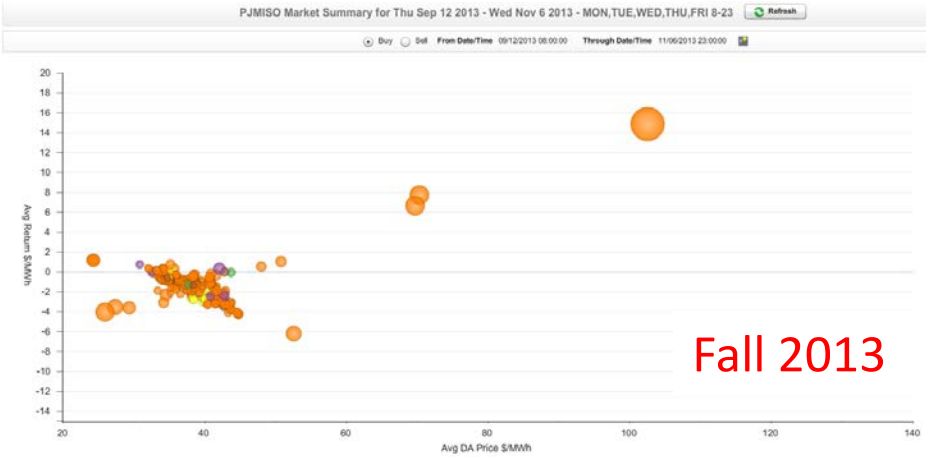
DART 'System Convergence Spread' Across All UTC Nodes

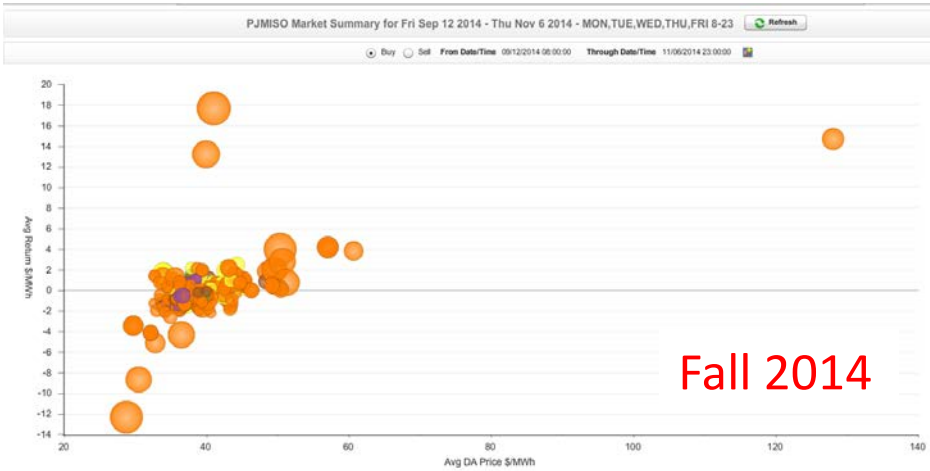


YES ENERGY

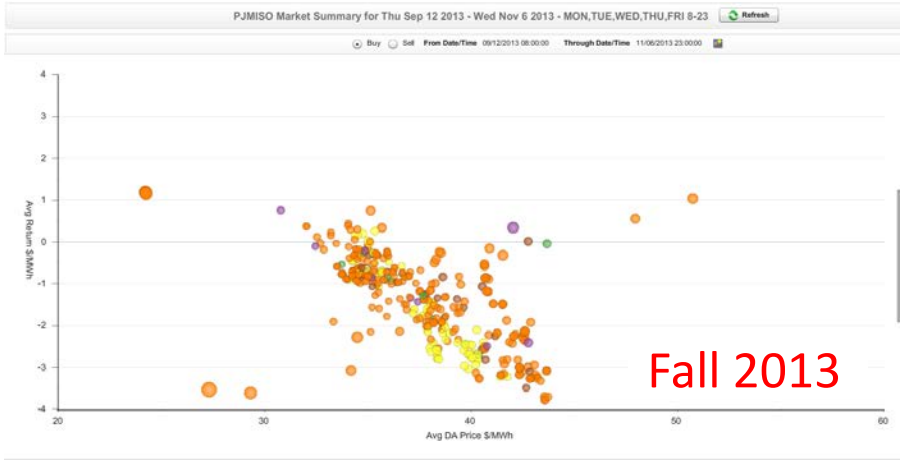
2013 vs 2014 System Convergence Spread

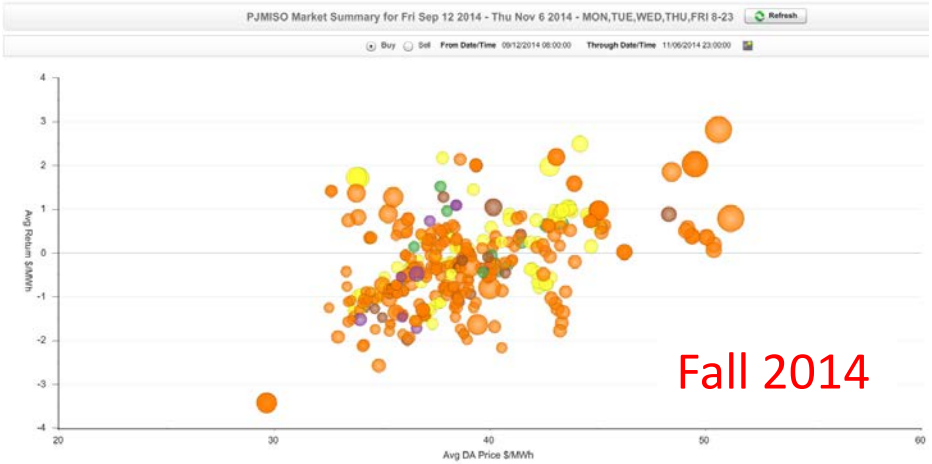
DART Across Nodes





DART Across – 'Normal Range'





Notes: 2013 and 2014 at best have similar amounts of system spread but clearly 2014 is not better by this measure of convergence.

YES ENERGY

Technical Appendix

Early analysis suggest that after the FERC order the market convergence improved:

```
. reg abs_dartreturn i.pre_post if year==2014, cluster(pointid)

Linear regression                                      Number of obs = 1063063
                                                       F(  1,  9177) = 1186.17
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.0047
                                                       Root MSE      =  173.41

                              (Std. Err. adjusted for 9178 clusters in pointid)
------------------------------------------------------------------------------
             |               Robust
abs_dartre~n |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  1.pre_post |  -24.16265   .7015687   -34.44   0.000    -25.53788   -22.78742
       _cons |   127.6427   .6262389   203.82   0.000     126.4152    128.8703
------------------------------------------------------------------------------
```

Note: pre_post is a dummy variable equal to 1 after the FERC order. Convergence improves by $

mean absolute value of the DART return is $116 suggesting convergence has improved by about

Technical Appendix

	UTC Volume	
	Model	Model w/ Controls
Post-Order	-124045.7***	-145249.5***
	(-2892.40)	(-972.52)
2014	392595.7***	395905.7***
	(4.93e+10)	(2580.37)
Diff-in-Diff	-989941.7***	-942213.3***
	(-23082.71)	(-5315.62)
Constant	1220480.9***	1247679.7***
	(1.53e+11)	(642.30)
Observations	1,481,503	1,320,393
R^2	0.669	0.733

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Controls omitted for space

Note: Full results for UTC volume regressions with and without controls.

```
. reg abs_dartreturn i.pre_post##i.year_2014 gas_price  maxtemp mintemp avgtemp sdtemp maxload c.maxload#c
> .maxload i.dow i.month, cluster(pointid)

Linear regression                                      Number of obs = 1921863
                                                       F( 18,  9454) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.1710
                                                       Root MSE      =   162.4

                                   (Std. Err. adjusted for 9455 clusters in pointid)
```

abs_dartreturn	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
1.pre_post	-12.01051	.9935618	-12.09	0.000	-13.9581	-10.06291
1.year_2014	13.42795	.3845527	34.92	0.000	12.67414	14.18175
pre_post#year_2014						
1 1	24.31642	.7347678	33.09	0.000	22.87612	25.75673
gas_price	5.743176	.3029785	18.96	0.000	5.149273	6.337079
maxtemp	-3.289014	.0765865	-42.95	0.000	-3.43914	-3.138888
mintemp	2.428147	.0800571	30.33	0.000	2.271218	2.585077
avgtemp	3.294542	.0954353	34.52	0.000	3.107468	3.481615
sdtemp	8.886956	.1852551	47.97	0.000	8.523816	9.250096
maxload	-.0624995	.0005423	-115.26	0.000	-.0635625	-.0614366
c.maxload#c.maxload	8.27e-07	6.58e-09	125.64	0.000	8.14e-07	8.40e-07
dow						
2	-19.75187	.2868777	-68.85	0.000	-20.31421	-19.18953
3	.9587571	.2237012	4.29	0.000	.5202547	1.397259
4	-3.454689	.3692876	-9.36	0.000	-4.178572	-2.730806
5	-5.260764	.2347768	-22.41	0.000	-5.720977	-4.800551
month						
7	-55.99956	.5179209	-108.12	0.000	-57.01479	-54.98432
8	-50.95542	.6115964	-83.32	0.000	-52.15428	-49.75656
9	-15.30422	.7978677	-19.18	0.000	-16.86821	-13.74023
10	6.186716	1.034795	5.98	0.000	4.158296	8.215136
11	32.79248	1.005325	32.62	0.000	30.82182	34.76313
_cons	1074.485	11.52192	93.26	0.000	1051.899	1097.07

Note: Full regression results for reference. Observed daily on peak.