Carbon prices and oil prices

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Background and motivation

- Carbon emissions are a new traded financial instrument. So, a natural question to ask is:

  How do carbon prices interact with other financial variables like oil prices, stock prices and interest rates?

Past research

- Recent papers on EU-ETS include:
- E. Alberola, J. Chevallier, B. Cheze, 2008;
- Mansanet-Bataller, M.,Pardo,A.,Valor,E.,2007;
- E. Benz, S. Truck, 2009;
- J. Chevallier, 2009, 2011;
- E. Alberola, J. Chevallier, B. Cheze, 2008;
- M. Mansanet-Bataller, J. Chevallier, M. Herve-Mignucci, E. Alberola, 2010;

Past research

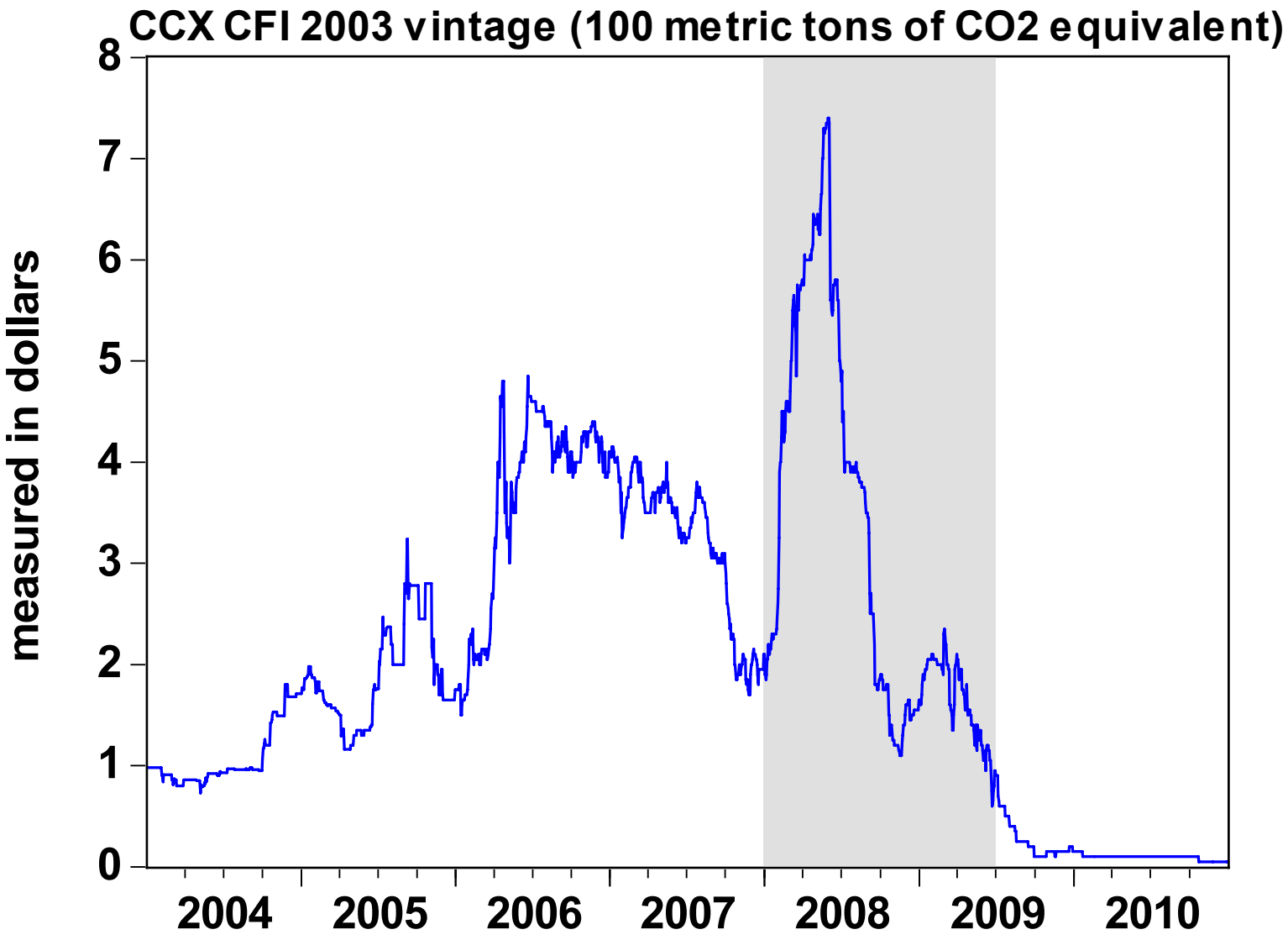
- Recent paper on CCX is:
- H.S. Kim and W.W. Koo, 2010
- Recent paper on Australia is:
- J. Chevallier, 2010

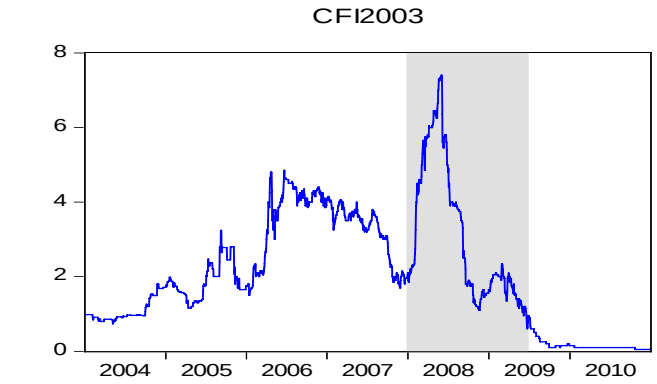
Objective

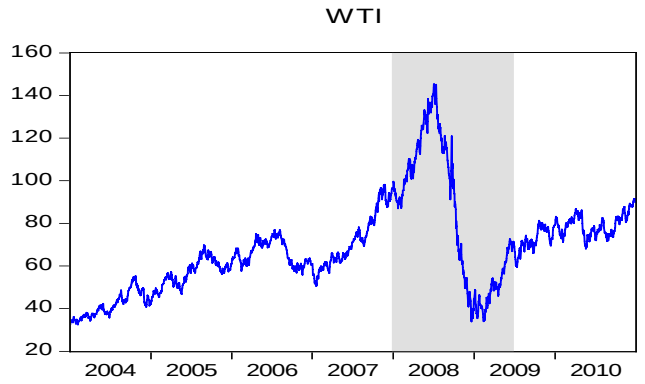
- Conduct a multivariable analysis of the dynamic interactions between carbon prices, oil prices, stock prices and interest rates.

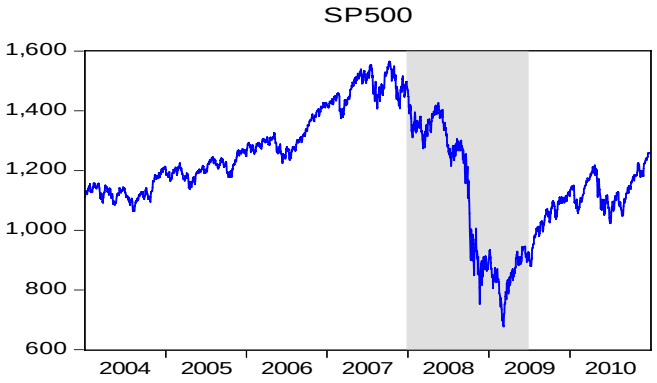
Data

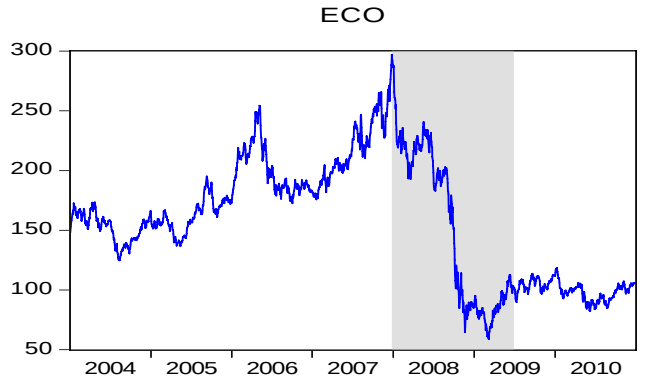
- Data on carbon prices (CCX CFI vintage 2003, 100 metric tons of CO2 equivalent), oil prices (WTI futures prices), stock prices (SP500, ECO), and interest rates (3 month T bill).
- On the CCX, earlier dated vintages may be delivered against later vintage trades.


CCX CFI 2003 vintage (100 metric tons of CO2 equivalent)
measured in dollars
0
1
2
3
4
5
6
7
8
2004
2005
2006
2007
2008
2009
2010


CFI2003
8
6
4
2
0
2004
2005
2006
2007
2008
2009
2010


WTI
160
140
120
100
80
60
40
20
2004
2005
2006
2007
2008
2009
2010


SP500
1,600
1,400
1,200
1,000
800
600
2004
2005
2006
2007
2008
2009
2010


ECO
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150
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2004
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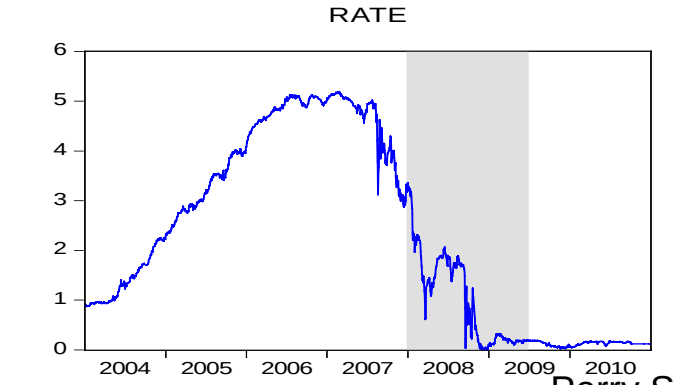
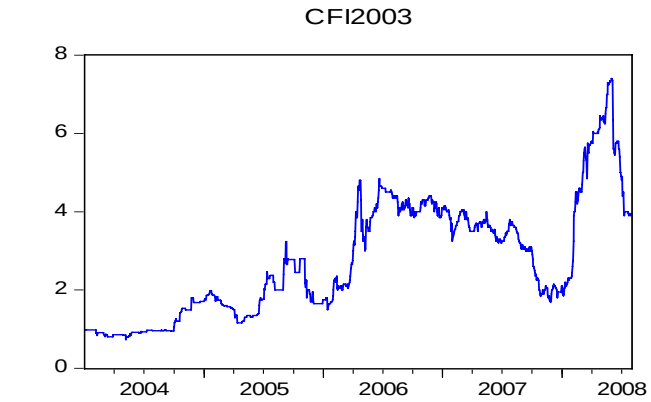
2010


RATE
6
5
4
3
2
1
0
2004
2005
2006
2007
2008
2009
2010

Data

- The Great Recession has caused a structural break so estimation period is, 1/02/2004 7/31/2008 (before the Lehman's bankruptcy).
- CCX trading volume was zero from February 2010 onwards and trading has now ceased.
- Intrade currently predicts a 5% (20%) probability of a cap and trade system being established before midnight Dec 31, 2011 (2013).


CFI2003
8
6
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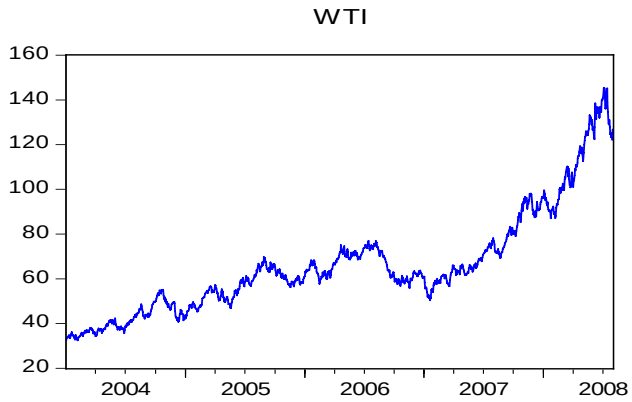
2004
2005
2006
2007
2008


WTI
160
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2004
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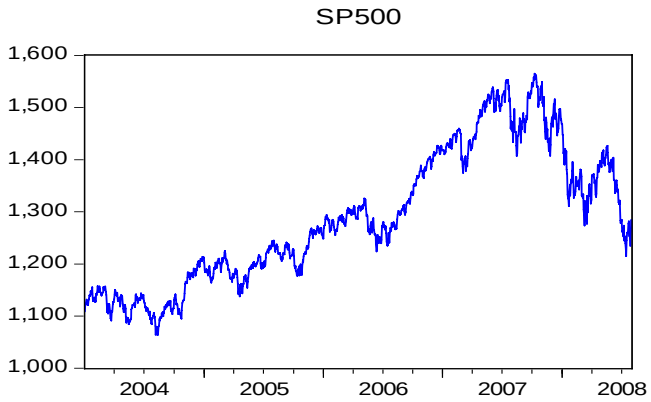
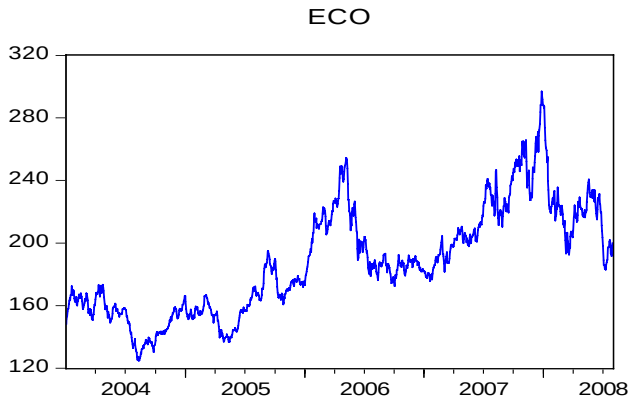
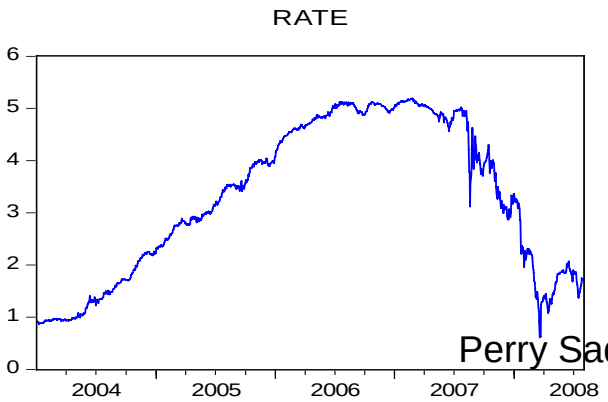
2008


SP500
1,600
1,500
1,400
1,300
1,200
1,100
1,000
2004
2005
2006
2007
2008


ECO
320
280
240
200
160
120
2004
2005
2006
2007
2008


RATE
6
5
4
3
2
1
0
2004
2005
2006
2007
2008

Summary statistics (daily data)

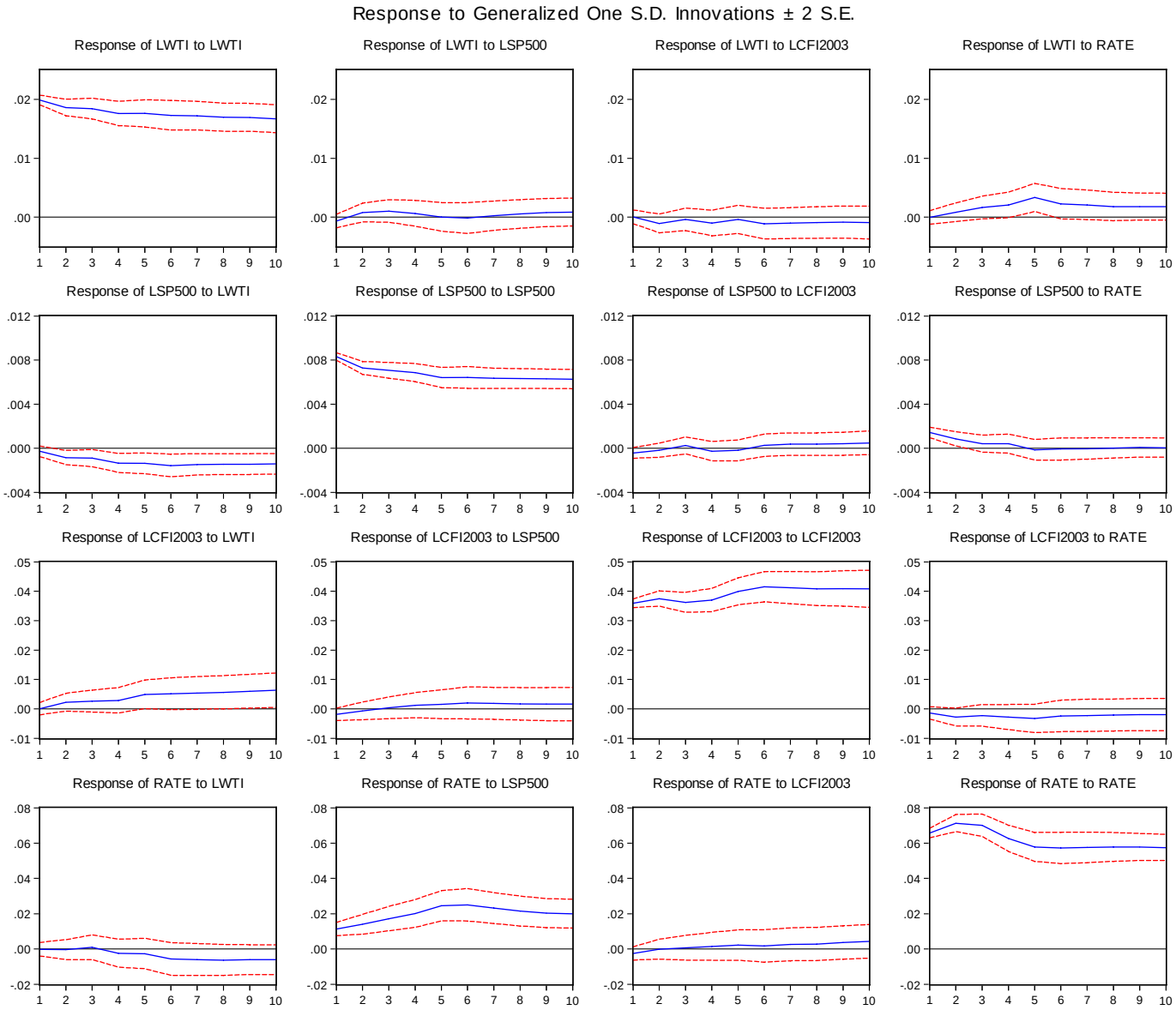
	%ΔCFI2003	%ΔWTI	%ΔSP500	%ΔECO	T bill
Mean	0.12	0.11	0.01	0.02	3.28
Median	0.00	0.11	0.05	0.04	3.41
Maximum	18.90	8.08	4.15	6.11	5.19
Minimum	-25.49	-7.70	-3.53	-6.88	0.61
Std. Dev.	3.61	2.01	0.84	1.62	1.46
Skewness	-0.29	0.02	-0.20	-0.19	-0.19
Kurtosis	14.68	3.41	5.38	4.15	1.58
Jarque-Bera	6800.77	8.28	289.86	72.57	107.67
Probability	0.00	0.02	0.00	0.00	0.00
Sharpe	0.03	0.01	0.00	0.05	
Nobs	1194	1194	1194	1194	1194

Empirical Approach

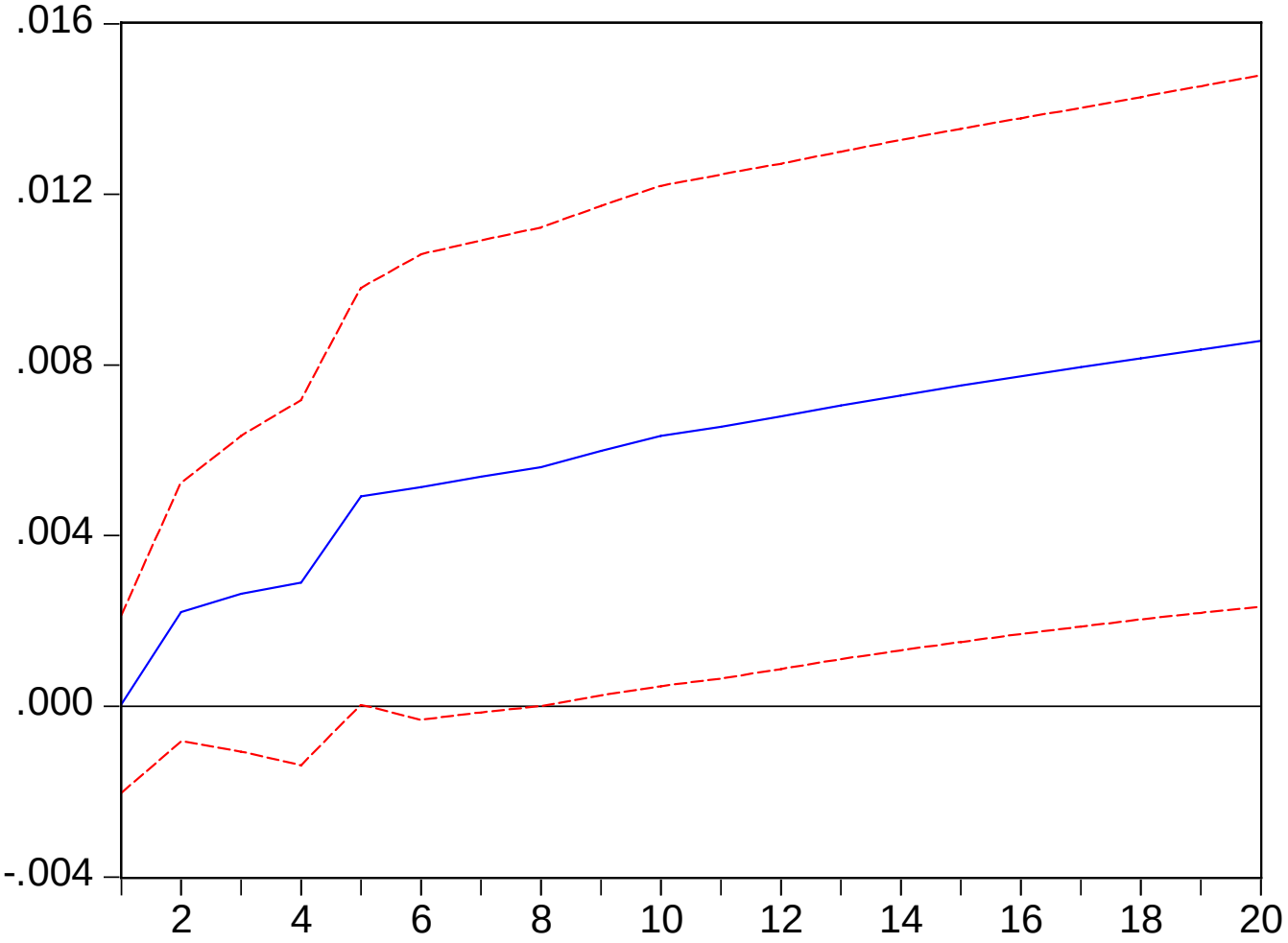
- Toda and Yamamoto (1995) Vector Autoregression (VAR) approach.
- Estimate the VAR in levels, use a standard lag length selection criteria to select appropriate lag length, and add additional lags if data contain unit roots or are cointegrated.

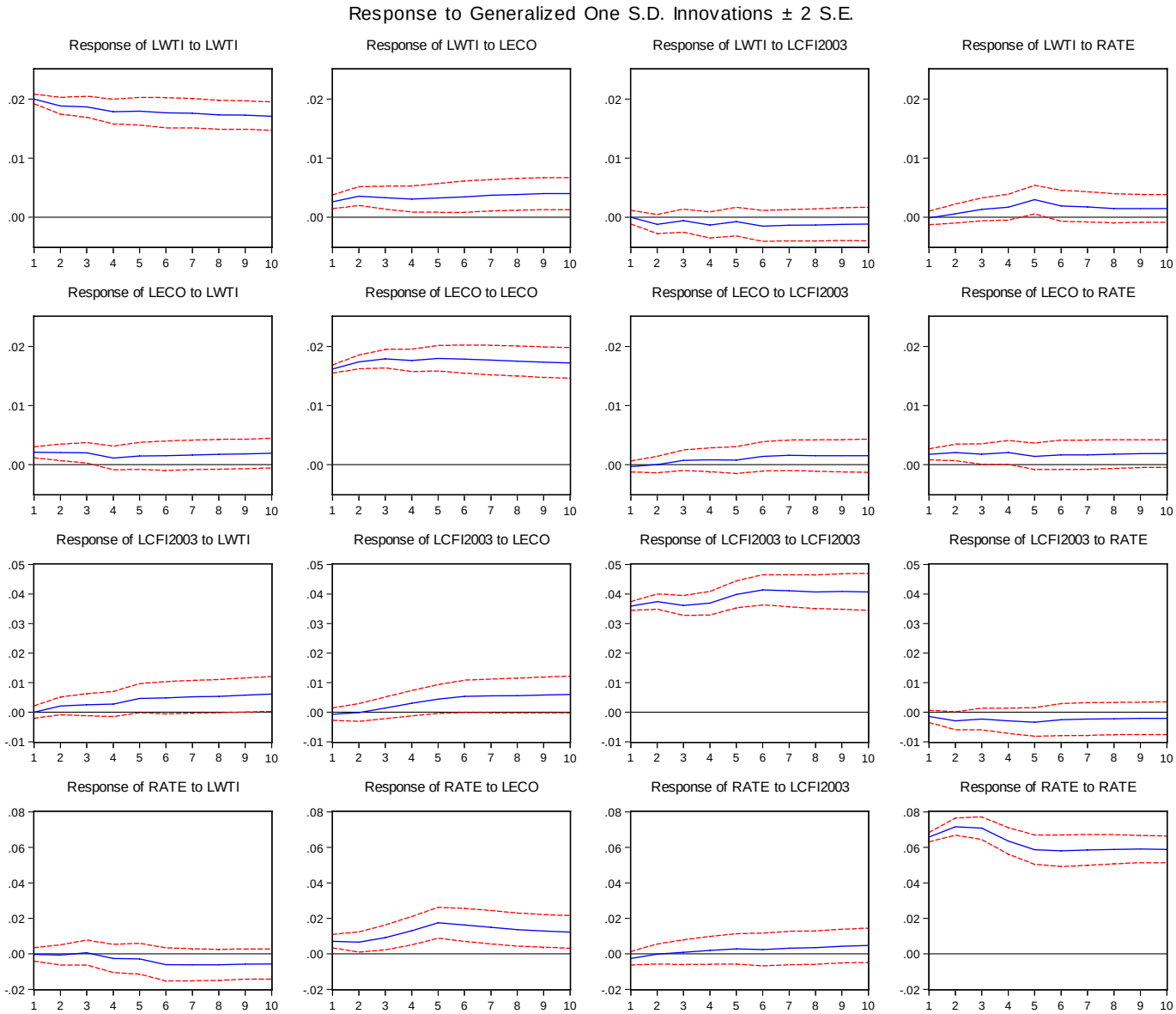
VARs

- One VAR for carbon, oil, SP500, interest rate.
- Another VAR for carbon, oil, ECO, interest rate.
- TY approach. LR selects 5 lags (plus one more lag for possible unit roots), so estimate VARs with 6 lags. AR roots less than unity (satisfies stability condition).


Response to Generalized One S.D. Innovations ± 2 S.E.
Response of LWTI to LWTI
Response of LWTI to LSP500
Response of LWTI to LCFI2003
Response of LWTI to RATE
Response of LSP500 to LWTI
Response of LSP500 to LSP500
Response of LSP500 to LCFI2003
Response of LSP500 to RATE
Response of LCFI2003 to LWTI
Response of LCFI2003 to LSP500
Response of LCFI2003 to LCFI2003
Response of LCFI2003 to RATE
Response of RATE to LWTI
Response of RATE to LSP500
Response of RATE to LCFI2003
Response of RATE to RATE

Response of LCFI2003 to Generalized One S.D. LWTI Innovation




Response to Generalized One S.D. Innovations ± 2 S.E.
Response of LWTI to LWTI
Response of LWTI to LECO
Response of LWTI to LCFI2003
Response of LWTI to RATE
Response of LECO to LWTI
Response of LECO to LECO
Response of LECO to LCFI2003
Response of LECO to RATE
Response of LCFI2003 to LWTI
Response of LCFI2003 to LECO
Response of LCFI2003 to LCFI2003
Response of LCFI2003 to RATE
Response of RATE to LWTI
Response of RATE to LECO
Response of RATE to LCFI2003
Response of RATE to RATE

Results

- Carbon prices increase in response to a one standard deviation shock to oil prices. Higher oil prices are associated with a growing economy and more emissions.

Results

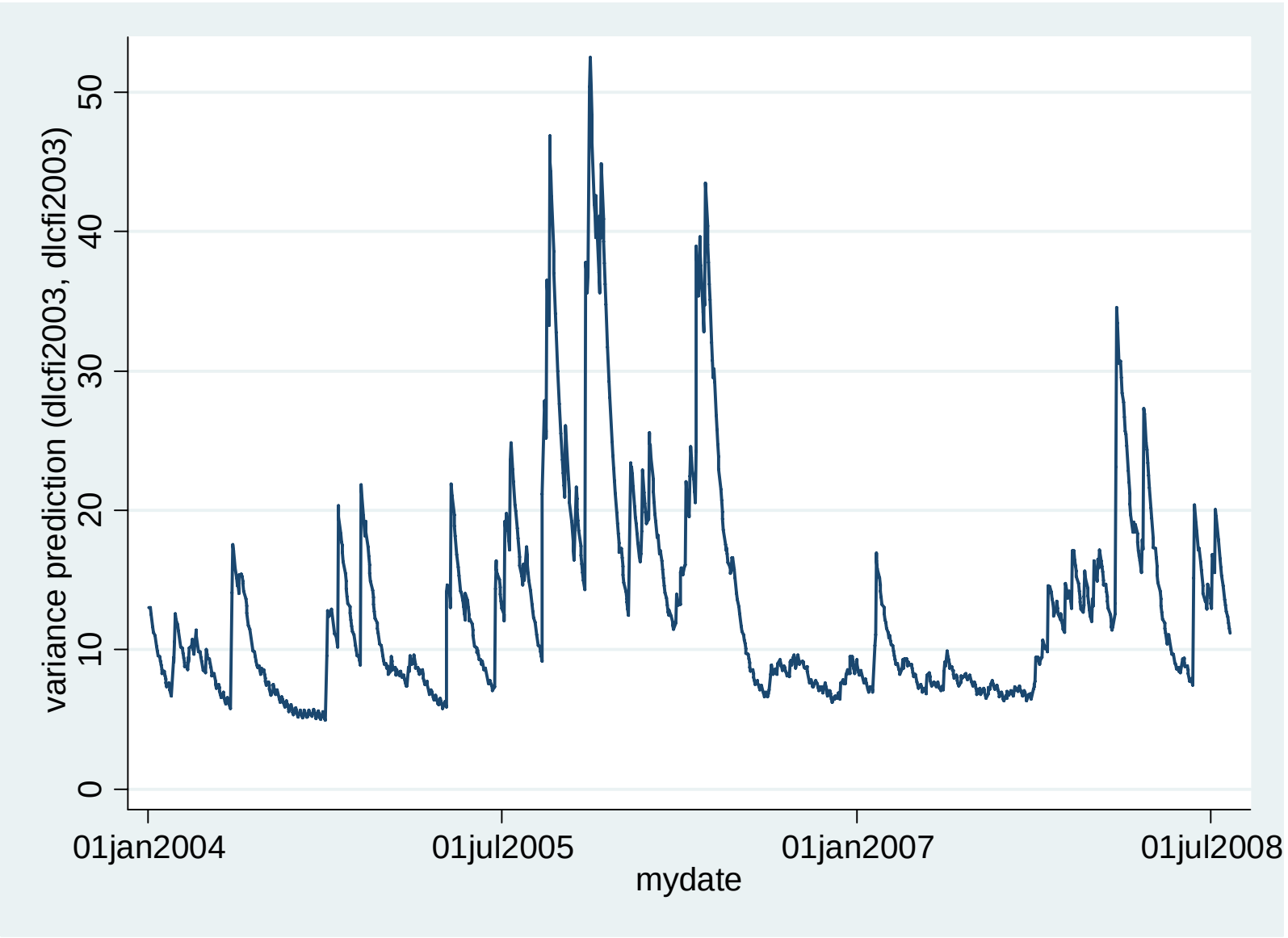
- The other financial variables do not respond statistically to shocks to carbon prices.
- A one standard deviation shock to oil prices reduces the S&P 500. This is in agreement with a large literature showing stock prices respond negatively to oil price increases (Sadorsky, 2008).

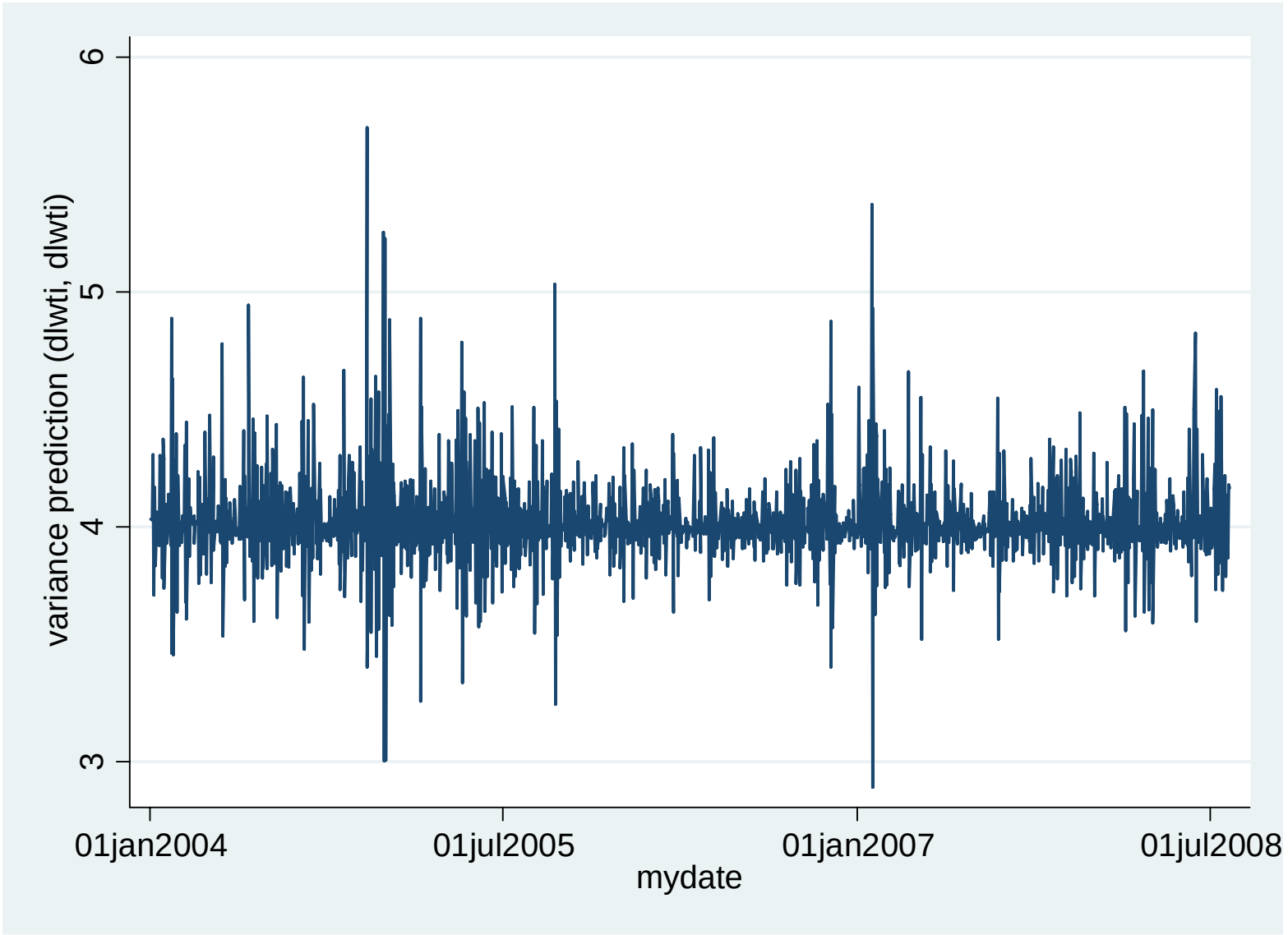
Results

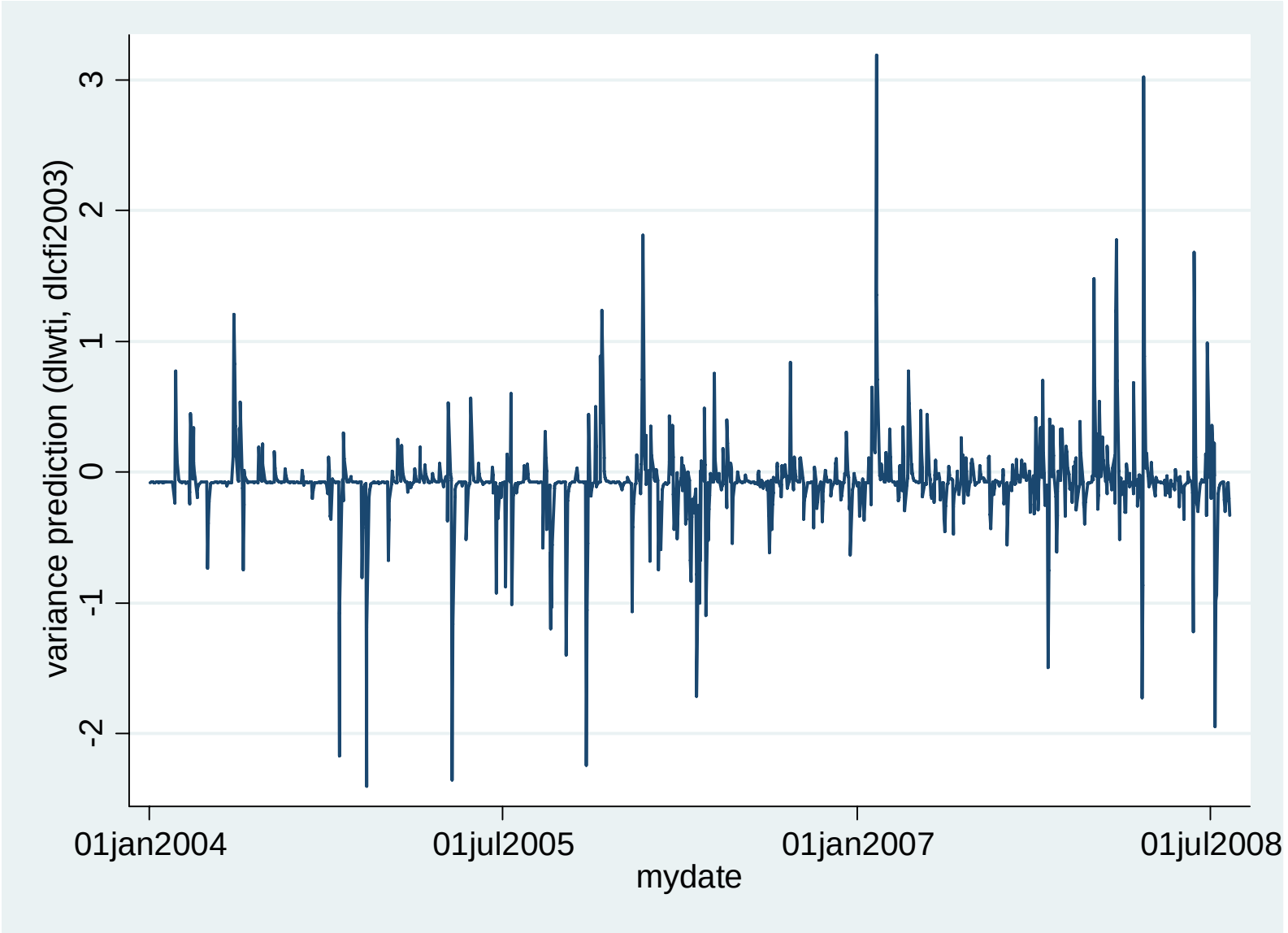
- A one standard deviation shock to oil prices increases ECO. This is in agreement with the idea that higher oil prices encourage investment in alternative energy. After 4 days, however, the impulse is statistically insignificant.

Results on volatility

- Use a MGARCH(1,1) model (Diagonal vech multivariate GARCH model) to estimate the conditional variances and covariances.


variance prediction (dlcfi2003, dlcfi2003)
0
10
20
30
40
50
01jan2004
01jul2005
01jan2007
01jul2008
mydate


variance prediction (dlwti, dlwti)
6
5
4
3
01jan2004
01jul2005
01jan2007
01jul2008
mydate


variance prediction (dlwti, dlcfi2003)
3
2
1
0
-1
-2
01jan2004
01jul2005
01jan2007
01jul2008
mydate

Implications

- These results help to understand price patterns of carbon.
- Oil prices are possibly useful for forecasting carbon prices.
- Hedging opportunities.
- Portfolio diversification (think of carbon as a traded commodity).
- Green portfolios and socially responsible investing.

Caveats

- Carbon emissions prices depend upon a vibrant market for carbon emissions. A vibrant market can come about because either

1. Companies voluntarily join (CCX)
2. Carbon emissions are regulated (EU-ETS)

Caveats

- Joining a voluntary market is useful for learning purposes but ultimately a regulated carbon market is more powerful than a voluntary market so the future of carbon markets depends upon carbon regulation.