Integration of the Global Emissions Market

Bruce Mizrach
Department of Economics
Rutgers University

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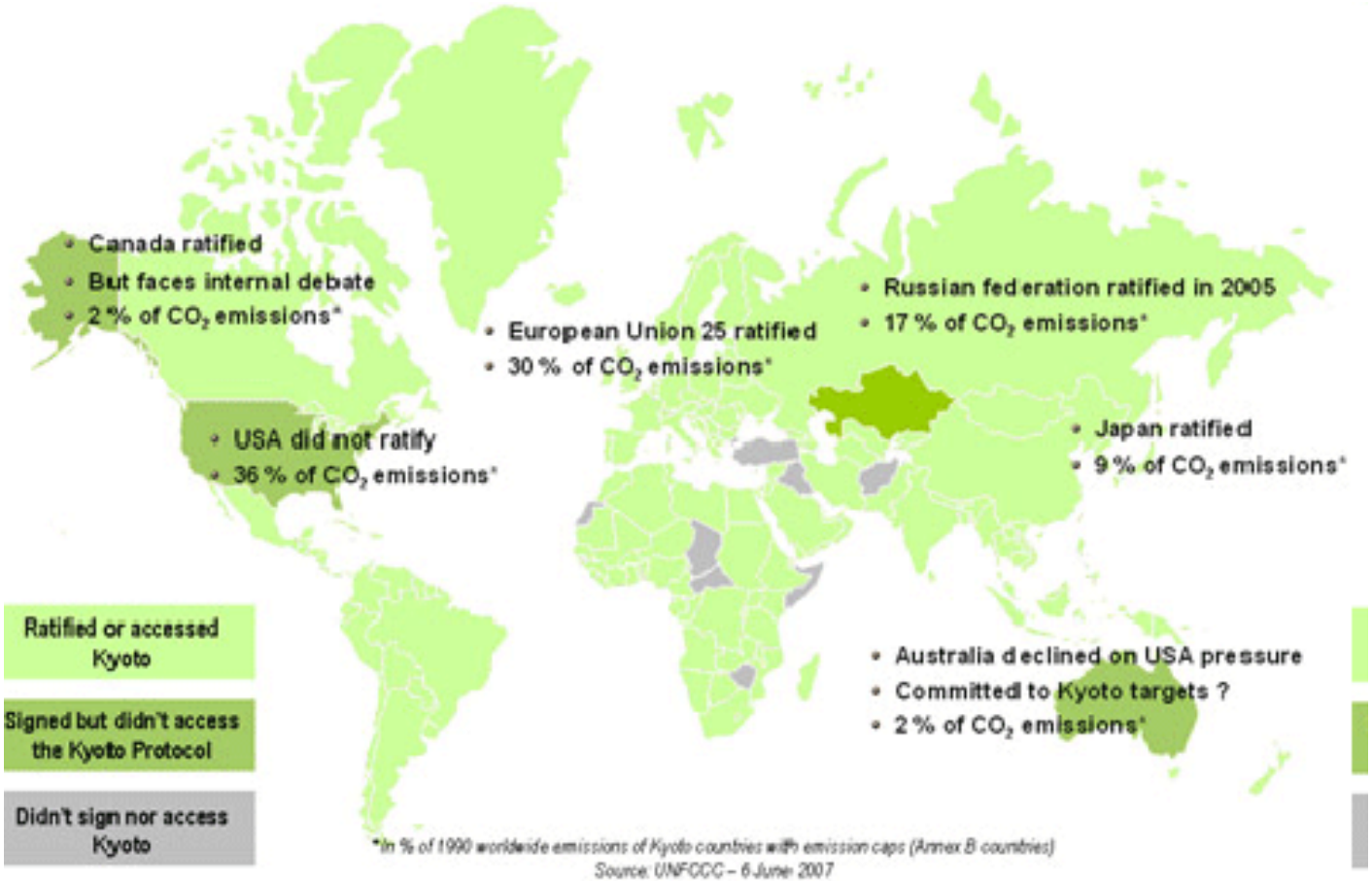
My normative assumptions

1. The price of GHG emissions should be positive.
2. Emissions trading schemes should facilitate a single global price.

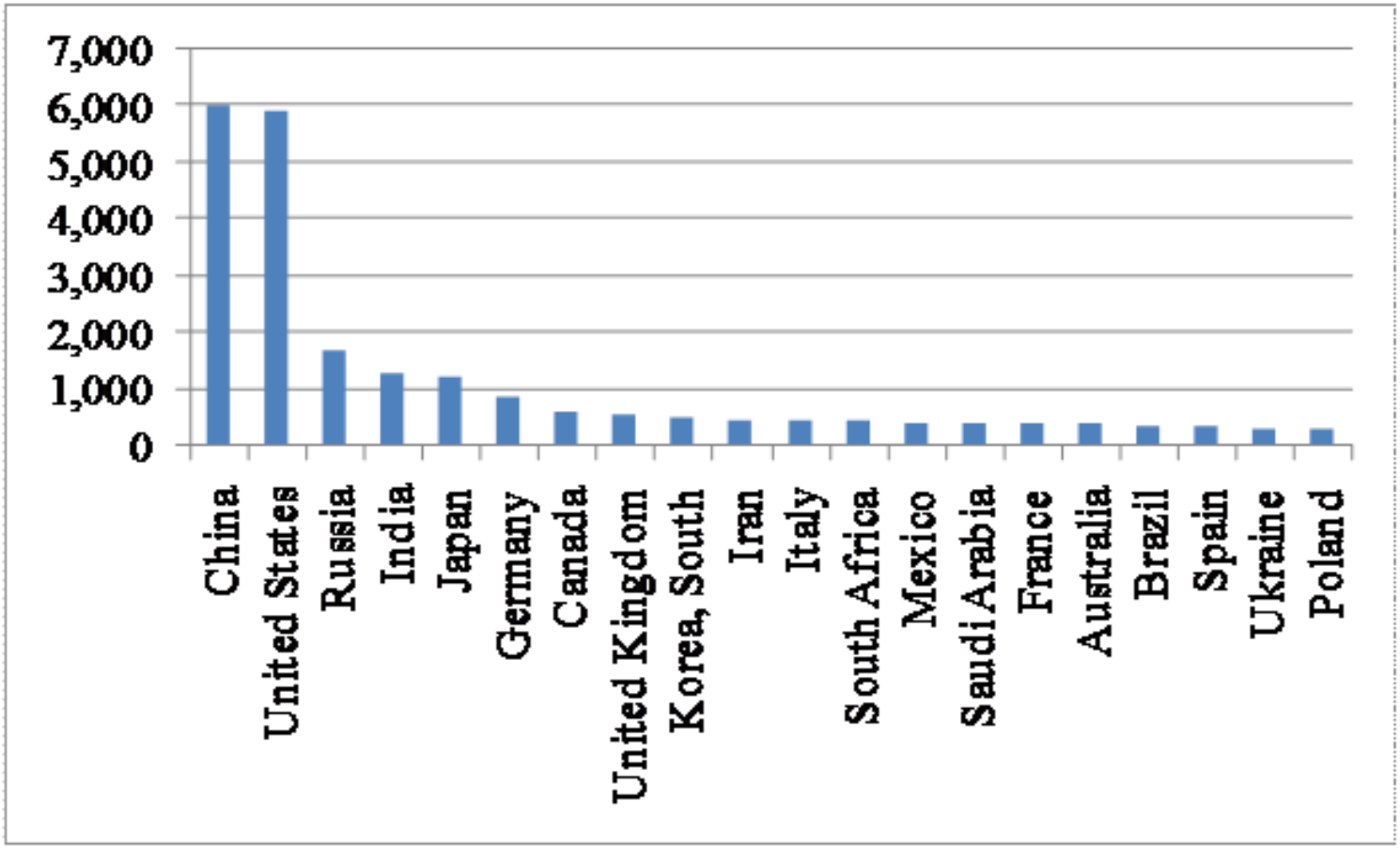
Timeline

- December 1997: The United Nations Framwork Convention on Climate Change (UNFCC) adopted the Kyoto Protocol.
- May 31, 2002: The European Union and its member states ratified the treaty.
- 2003/87/EC: Called upon member states to create national allocation plans (NAP).
- December 2004: The European Commission had approved plans for all the major European economies.
- January 2005: European Union Greenhouse Gas Emission Trading Scheme (EU ETS) begins operations.
- April 6, 2009: 2009/29/EC Phase III EU-wide limits for 2013-20 for a 20% reduction in greenhouse gases by 2020.

Who's In and Who's Out



Top 20 Emitters



Note: China, US and India are outside the treaty, and Russia has a non-binding quota.

EU Emissions Trading System (EU ETS)

The system is based on the allocation of allowances to emit one tonne of carbon dioxide equivalent during a specified period. This basic trading unit is called a European Union Allowance (EUA).

The scheme began with a "warm-up" Phase I from 2005-2007, to be followed by successive 5-year periods. Phase II, from 2008-2012, coincides with the Kyoto compliance period.

Phase II National Allocation Plans

	Allowed Cap		2005 emissions	
	MMtCO2e	% total	MMtCO2e	% adj.
France	132.80	6.30%	136.40	-2.60%
Germany	453.10	21.60%	485.00	-6.60%
Italy	195.80	9.30%	225.50	-13.20%
Poland	208.50	9.90%	209.40	-0.40%
Spain	152.30	7.30%	195.60	-22.10%
Neth.	85.80	4.10%	84.40	1.70%
UK	246.20	11.70%	281.90	-12.70%
EU-EEA	2,097.70	100.00%	2,231.80	-6.00%

Sources of Supply

The Kyoto protocol has three avenues for creating supply of emission credits:

1. Assigned Amount Units (AAU)
2. Clean Development Mechanism (pCER)
3. Joint Implementation (ERU)

Assigned Amount Units

AAUs credits are generated when there are gaps between a country's emission targets, and their actual output. The majority of these credits come from transition countries, Russia and the Ukraine.

Many have argued that these credits have not been legitimately earned because many of the carbon emitting factories would have been eliminated anyway. To handle this politcally, there have been several Green Investment Schemes (GIS) proposed so that proceeds from the sale of AAUs are actually dedicated to GHG reduction.

AAU supply

Country	MMtCO2e
Russia	3,330
Ukraine	2,170
EU	1,720
Other EIT	85
Total	7,305

Source: IETA (2008)

AAU demand

Article 17 allows for inter-government trading of excess credits, but the first trades did not take place until the fall of 2008. According to Point Carbon, 75 MMtCO2e traded in the first half of 2009, with a value of €750m, up 74% from 43 MMtCO2e with market value €330m in the second half of 2008.

Japan has been among the most active countries in the AAU market with 71.5 million in purchases from Latvia (1.5 million, Oct.2009), Ukraine (30 million, March 2009) and the Czech Republic (40 million, March 2009), following on 16.6 million AAUs purchased in 2008 from Switzerland, Ukraine, and Slovakia.

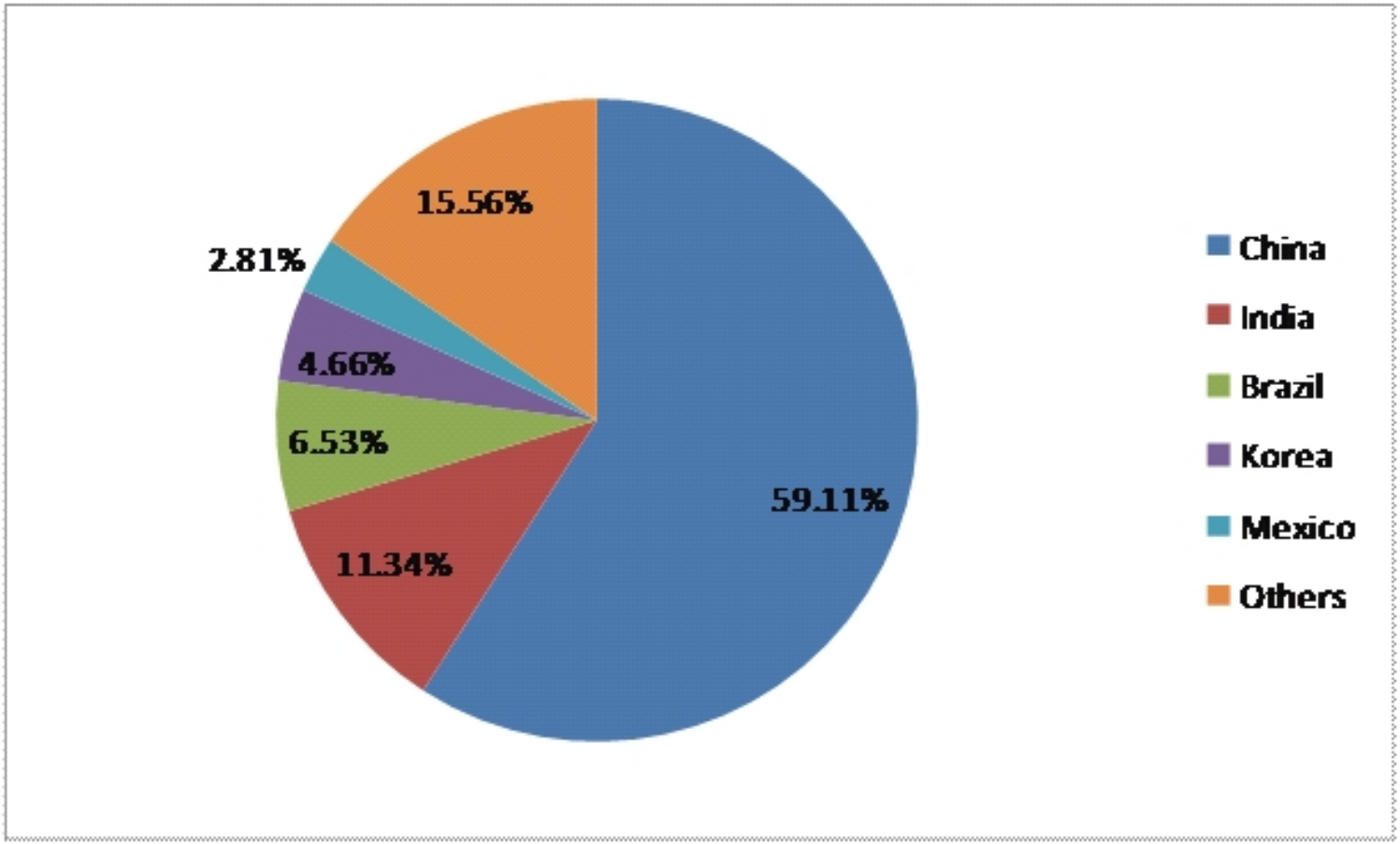
Poland will soon sign a deal to sell a total 40 million euros ($60 million) of surplus greenhouse gas emission rights to Spain and Ireland, the country's first such government-to-government deal under the Kyoto Protocol, its environment minister said.

Clean Development Mechanism

Article 12 created The Clean Development Mechanism (CDM) which provides certified emission reduction (CER) credits towards Kyoto targets for projects in developing nations. These credits are now refererred to as primary CERs (pCER), and they trade at a discount to the second market sCERs. The UNFCC maintains a database of projects approved by the CDM executive board.

The first project approved was the Brazil NovaGerar Landfill Gas to Energy Project in November 2004. This was a large waste handling and disposal facility financed by the Netherlands which receives 0.670 MMtCO2e per annum of credits.

Total pCER



As of December 2009, 1,946 projects have been approved by the CDM executive board which produce an annual average of 329.5 million CERs.

10 dirtiest EU plants: total emissions

Country	Plant	2008 MMtCO2e
Poland	Elektrownia Belchatow	30.863
Germany	Kraftwerk Niederaußem	24.866
Germany	14310-0918	23.457
UK	Drax Power Station	22.300
Germany	Kraftwerk Weisweiler	21.441
Germany	Kraftwerk Frimmersdorf	18,550
Germany	Kraftwerk Neurath	17.950
Italy	Brindisi Sud	14.915
Poland	Elektrownia Turow	12.880
Germany	14310-0921	12.461

Source: EU Community Independent Transaction Log

Top 10 net demand for offsets

		2008 Emissions MMtCO2e		
Country	Plant	Verified	Allocated	Net
UK	Drax Power Station	22.300	9.501	12.799
Germany	14310-0918	23.457	12.231	11.226
Germany	Kraftwerk Weisweiler	21.441	10.630	10.811
Germany	Kraftwerk Frimmersdorf	18.550	8.172	10.379
Germany	Kraftwerk Niederaußem	24.866	14.559	10.308
Germany	Kraftwerk Neurath	17.950	8.380	9.571
Italy	Stabilimento di Taranto	9.269	3.932	5.337
UK	Cottam Power Station	10.157	4.891	5.266
Germany	14310-0915	9.307	4.270	5.037
UK	Ratcliffe on Soar power station	9.901	4.943	4.959

Source: EU Community Independent Transaction Log

Rank correlation

Country	Plant	2008 Rank
UK	Drax Power Station	4
Germany	14310-0918	2
Germany	Kraftwerk Weisweiler	5
Germany	Kraftwerk Frimmersdorf	6
Germany	Kraftwerk Niederaußem	2
Germany	Kraftwerk Neurath	7
Italy	Stabilimento di Taranto	NR
UK	Cottam Power Station	NR
Germany	14310-0915	NR
UK	Ratcliffe on Soar power station	NR

4 of 10 of the dirtiest plants are not on the list of biggest net demand.

Plant level demand: EUA, CER, and ERU

There were 10,510 installations with verified emissions in the Community Independent Transaction Log for 2008 (based on the August 26, 2009 data release). These facilities produced a total of 2,112 MMtCO2e. Under the Phase II NAPs, the plants were allocated a total of 1,909 MMtCO2e, leaving a net demand of 201.97 mtCO2e.

To satisfy the demand, the plants surrendered 82.482 MMtCO2e in CER, and 0.048 MMtCO2e in ERU. The remainder, 119.466 MMtCO2e, was presumably satisfied through EUA, obtained in either OTC or screen based transactions.

Exchanges

There are 9 primary exchanges for EUA/CER trading:

1. European Climate Exchange
2. Nordpool (Nasdaq)
3. EEX (Eurex)
4. BlueNext (Euronext)
5. GME
6. Green Exchange (CME/NYMEX)
7. EXAA
8. Climex
9. Chicago Climate Exchange

Other exchanges

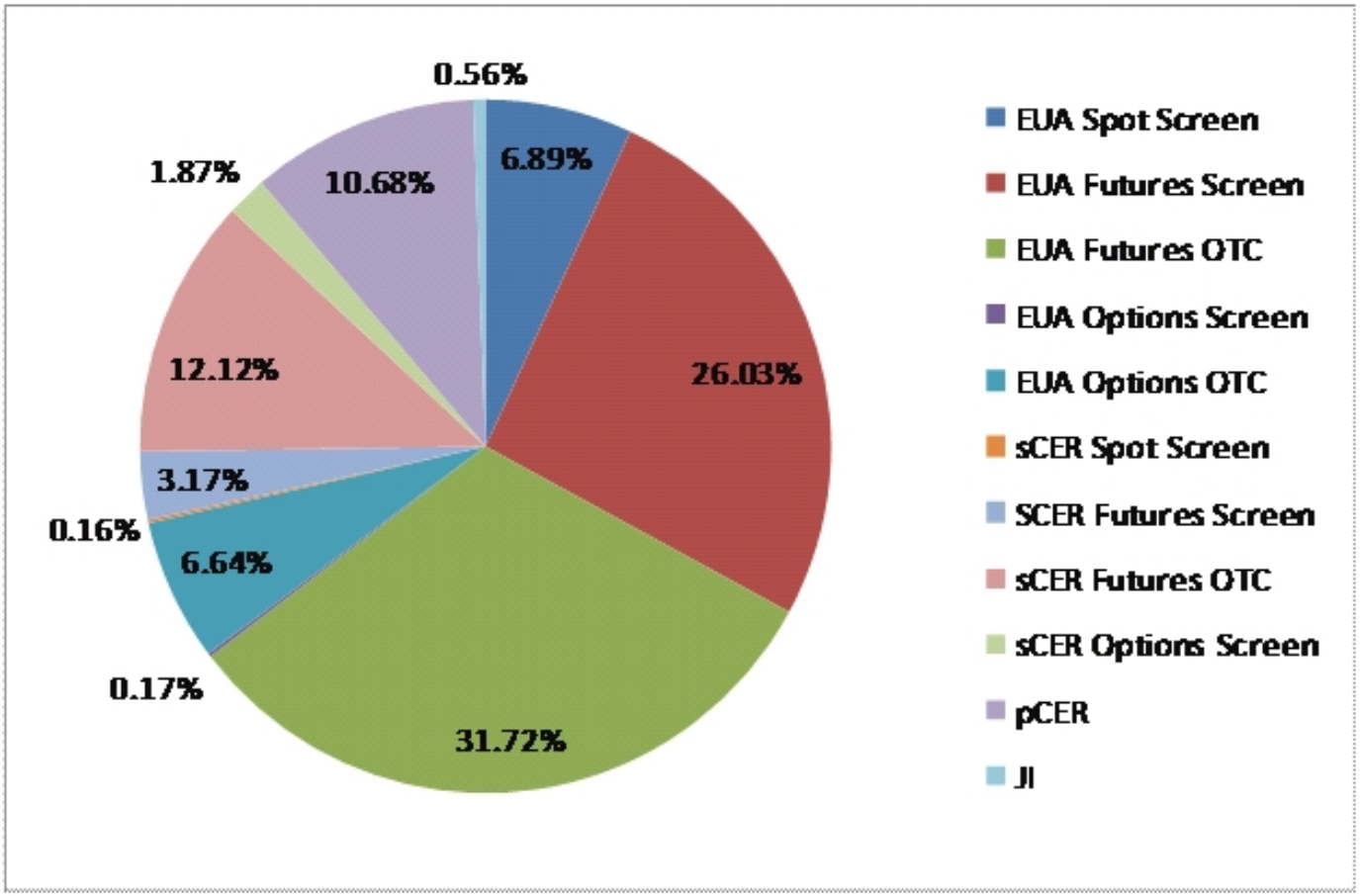
Country	City	Name
India	Mumbai	Multicommodity Exchange
India	Mumbai	National Commodity and Derivatives Exchange
China	Tianjin	Tianjin Climate Exchange
Singapore	Singapore	Asia Carbon Exchange
Japan	Tokyo	JBIC
Australia	Sydney	NSW Greenhouse Gas Abatement
Australia	Perth	Australian Climate Exchange
New Zealand	Wellington	New Zealand Carbon Exchange
Brazil	Sao Paolo	Brazilian Mercantile and Futures Exchange

OTC brokers

There are 9 major over-the-counter (OTC) brokers:

1. APX Power UK;
2. CantorCO2e;
3. Evolution Markets;
4. GFI Group;
5. ICAP;
6. MF Global Energy;
7. Spectron;
8. TFS Energy;
9. Tullet Prebon.

Overview of traded instruments



EUA Trading Volumes

	Screen Market Share						OTC Market Share		
	Volume	ECX	Nordpool	BlueNext	EEX	EXAA	Volume	ECX	Nordpool
2005	55.8	63.57%	23.63%	7.81%	4.66%	0.33%	66.7	77.88%	22.12%
2006	233.9	72.33%	7.41%	13.27%	6.87%	0.13%	319.5	86.78%	13.22%
2007	451.0	83.30%	5.92%	5.26%	5.46%	0.06%	717.0	91.25%	8.75%
2008	1,180.9	70.42%	2.03%	20.87%	6.68%	0.01%	1,368.5	93.45%	6.55%
2009	3,293.6	65.59%	0.63%	32.79%	0.98%		2,114.4	98.85%	1.15%

Average ECX prices for EUA: 2005 €21.59; 2006 €17.95; 2007 €19.59; 2008 €22.66; 2009 €13.58;

sCER Trading Volumes

		Screen Market Share				OTC Market Share		
	Volume	ECX	Nord Pool	BlueNext	EEX	Volume	ECX	Nordpool
2007	5.7	0.00%	100.00%	0.00%	0.00%	24.5	0.0%	100.0%
2008	185.4	91.43%	4.23%	3.02%	1.32%	432.0	88.41%	11.59%
2009	298.4	91.63%	0.57%	7.58%	0.22%	610.0	99.42%	0.58%

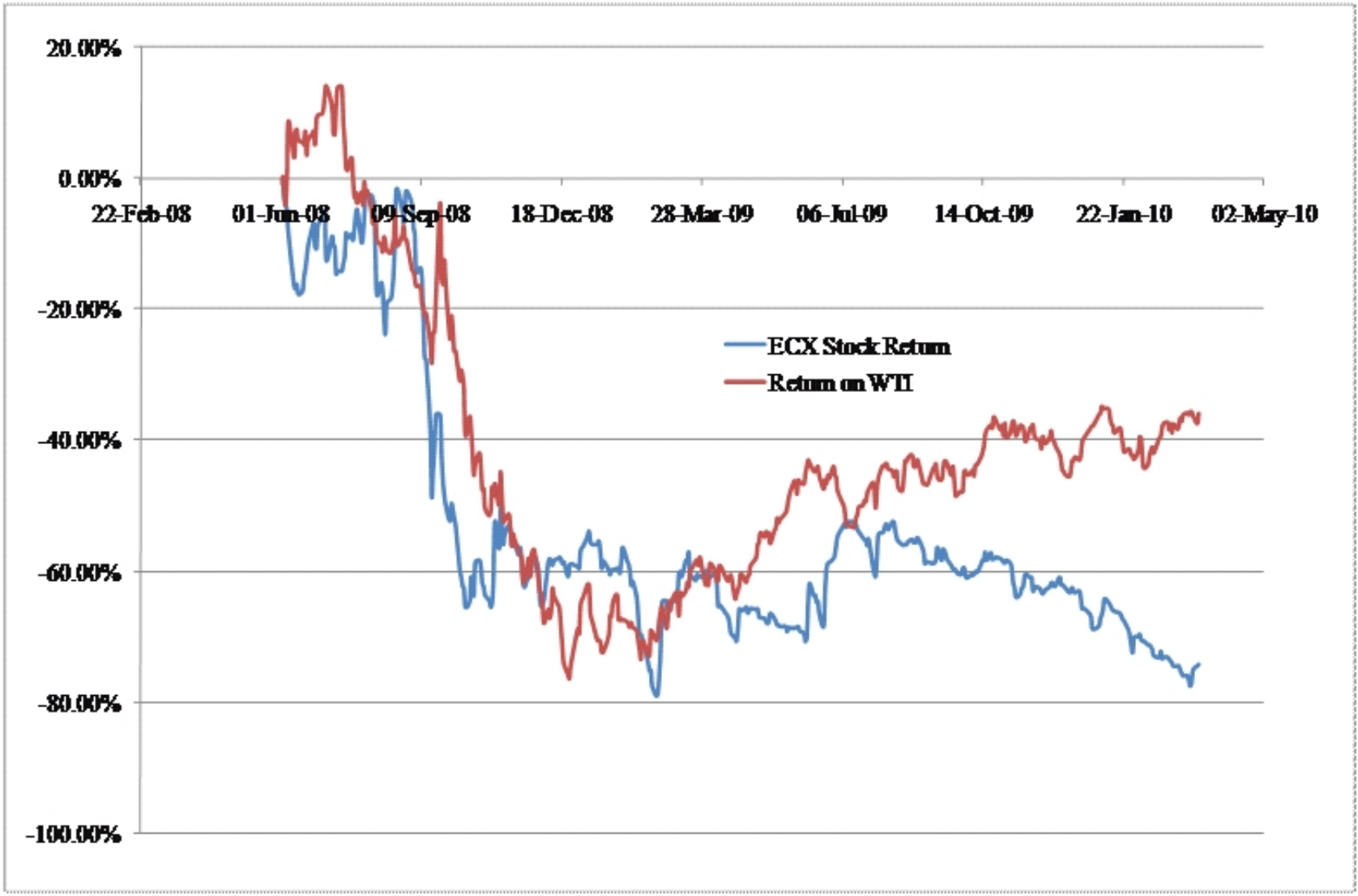
Average ECX prices for CER: 2008 €17.95; 2009 €11.78;

The EUA-CER spread has declined but is still not cointegrated: Mizrach (2010 *Point Carbon* and WP #2010-01).

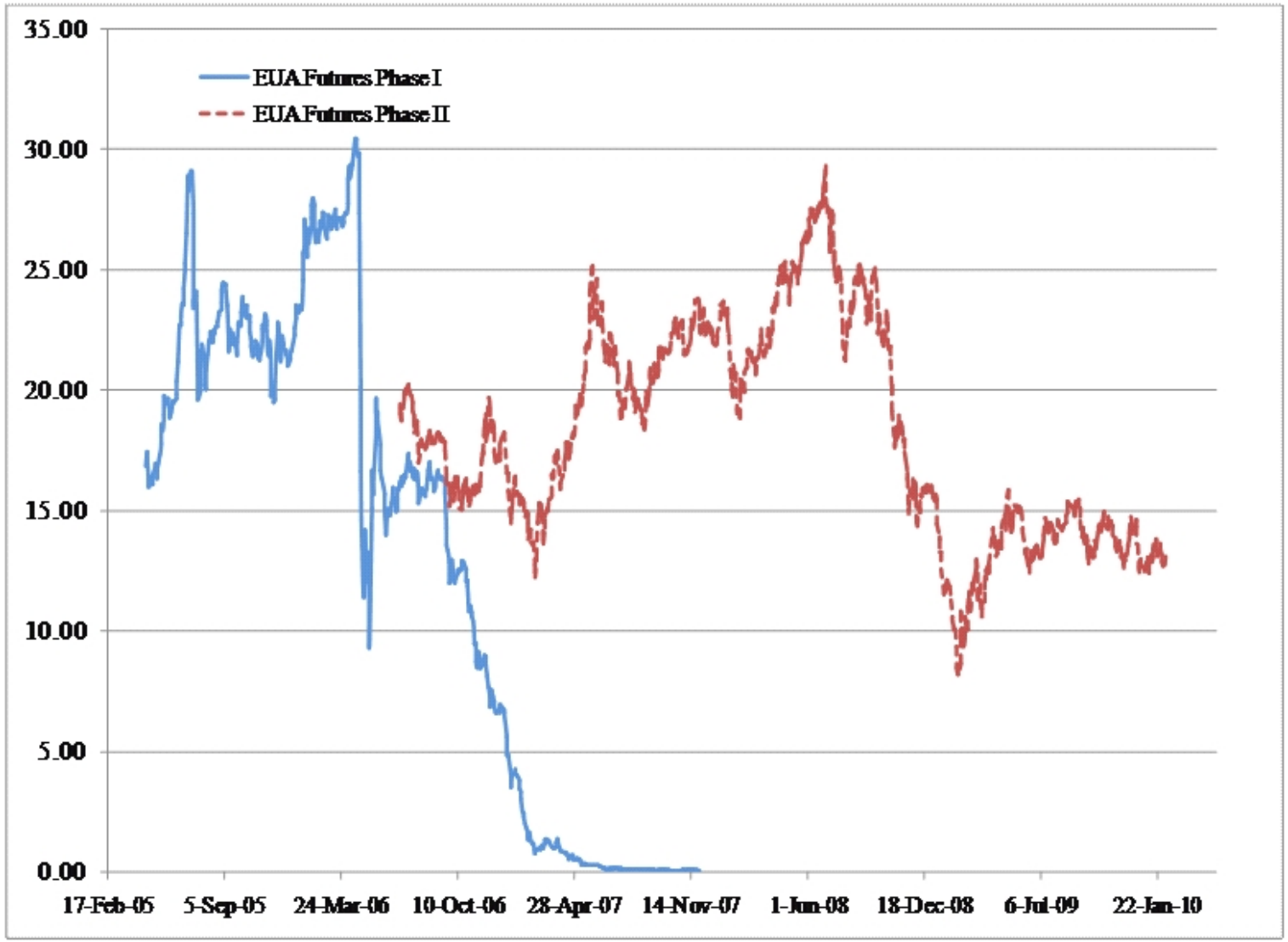
European Climate Exchange - market capitalization

At the March 22 market price of 540p, the market cap is £249.80mn.

ECX return has stopped tracking oil



EUA prices: Phase I and II



Cointegrating vector

Assuming that each price has a unit root,

$$\Delta p_{i,t} = p_{i,t} - p_{i,t-1} = \varepsilon_{i,t},$$

where $\varepsilon_{i,t} \tilde{} N(0, \sigma_{\varepsilon}^2)$, but some $r \times 1$ linear combination of the prices is stationary,

$$z_t = \beta' X_t,$$

then I can write the error correction model as

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \cdots + \Gamma_{k-1} \Delta X_{t-k+1} - \alpha z_{t-1} + u_t,$$

where α and β are $n \times r$ matrices.

The dimension of the cointegrating vector r, the weights in the linear combination β and the speeds of adjustment α are the crucial parameters in the analysis.

Johansen rank test

Johansen (1991) describes a procedure for determining the rank of β using canonical correlations. Denote the eigenvalues of this system by λ, he then defines the statistic,

$$-T\sum_{j=r+1}^{n}\log(1-\lambda_j).$$

This tests the null that the matrix β has rank r (the system has $n-r$ unit roots) and is distributed asymptotically $\chi^2(r)$.

I follow much of the literature and utilize a finite sample correction from Reimers (1992),

$$-(T+nk)\sum_{j=r+1}^{n}\log(1-\lambda_j).$$

In practice, I will work my way up from $r=0$ to $r=n$, stopping at the first value for r which fails to reject the null.

Integration tests

- Integration across exchanges: spot and futures. $\boxed{\surd}$
- Spot and futures parity $\boxed{\surd}$
- Integration along the futures yield curve $\boxed{X}$
- EUA-CER integration $\boxed{X}$

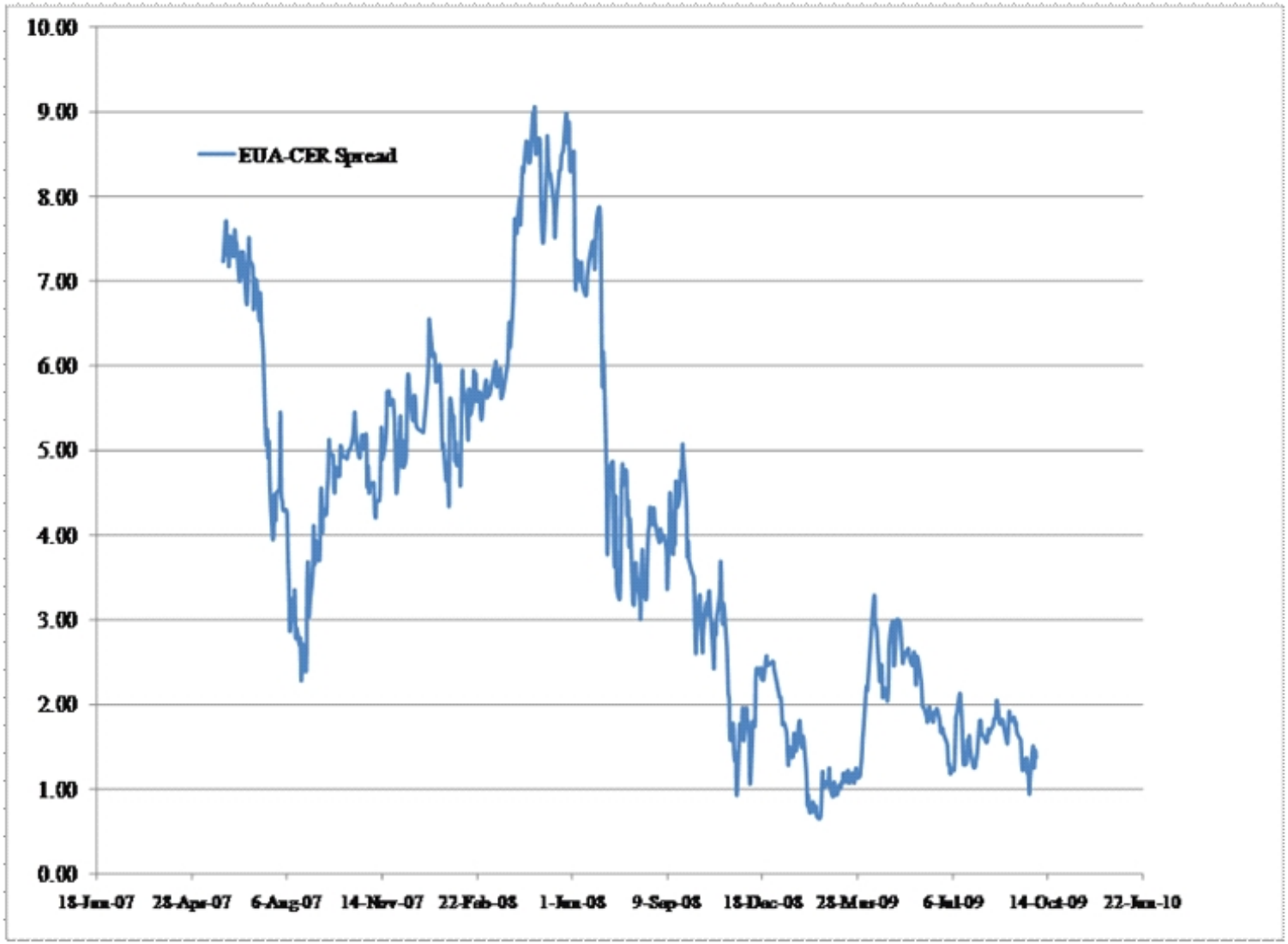
ECX futures curve 2008-12

I examine five maturities for the Phase II EUA futures, the December expiries from 2008 to 2012. I analyze the period following the breakdown in Phase I EUA: May 2006 to December 15, 2008 when the December 2008 contract expires. The trace test for the five series, reported in Table 15, implies as many as four distinct trends ($n = 5, r = 1$).

I start the sample in 2008 to see if the markets became more closely integrated, extending the sample to September 30, 2009 for the 2009-2012 expiries. The trace test now finds just two common trends. The only pair of futures which I find to be cointegrated though are the 2010 and 2011 expiries.

My conclusion is that policy uncertainties prevent the market from looking at these as nearly perfect substitutes.

EUA-CER Spreads

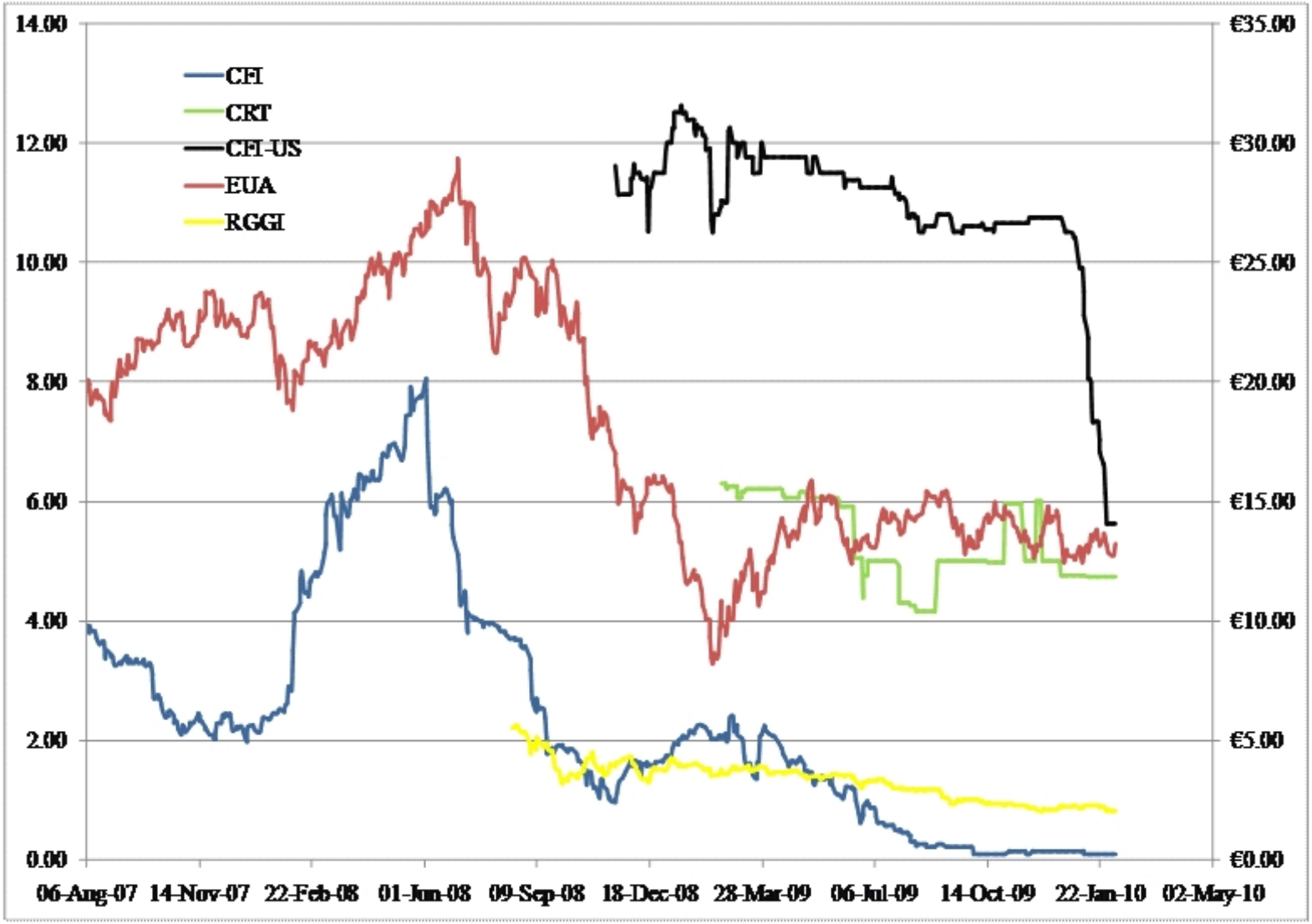


Major N. American programs

1. Acid rain program - focuses on SO2, started in 1990!!, achieved target 3 years ahead of schedule.
2. Regional Greenhouse Gas Initiative (RGGI) - regional CO2 initiative
3. California Climate Reserve (CRT)
4. Voluntary market (CFI, CFI-US).

All 4 programs have related instruments trading on the Chicago Climate Exchange.

North American secondary market prices



Cointegration with EUA

Prior to the Waxman-Markey bill (June 2009), EUA and CFI contracts were cointegrated.

CFI-US prices collapsed with Scott Brown election (January 2010).

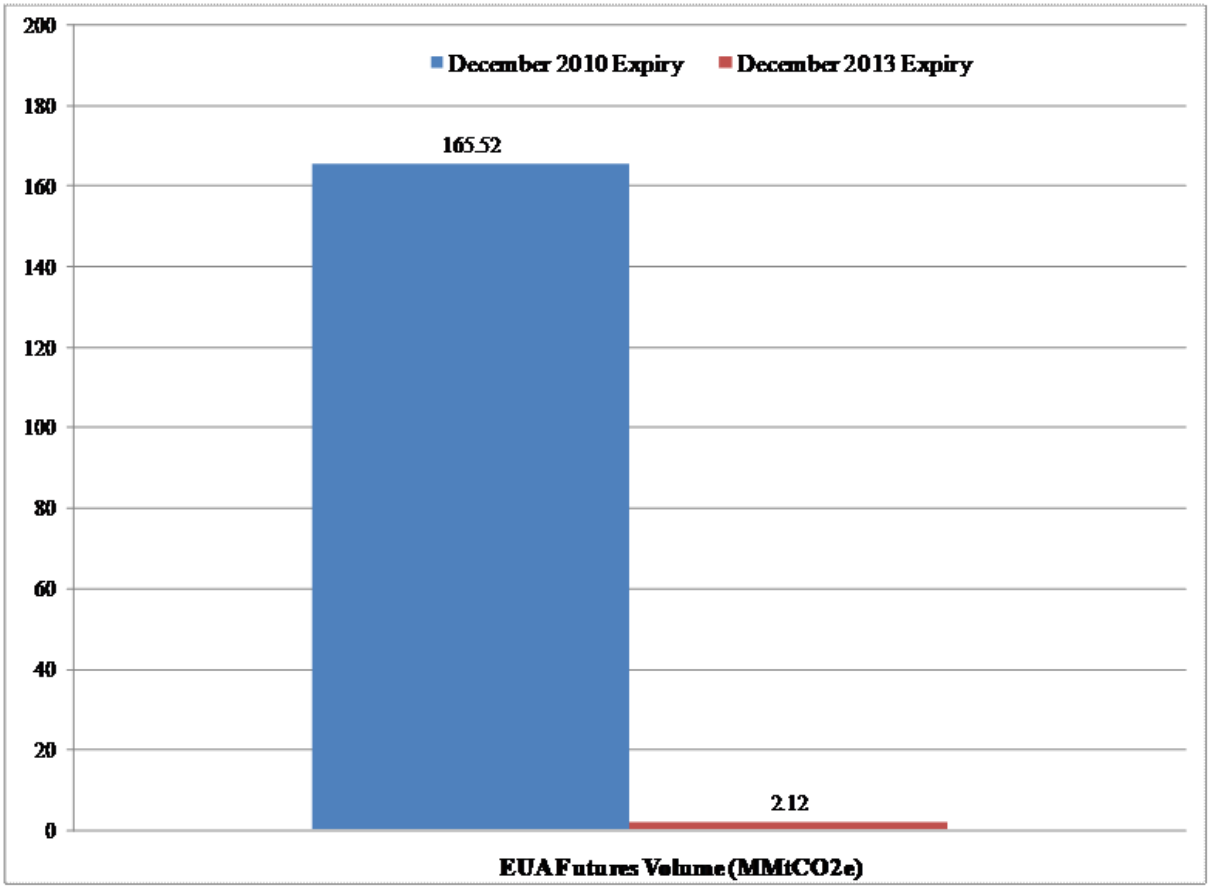
RGGI and CRT prices have remained (relatively) steady.

The good news

It has stopped snowing in Washington, D.C.

US-EU ETS convergence probability

Copenhagen uncertainty hurting futures trading



AAU overhang

With the global recession reducing industrial production, there has been a significant decline in Annex B demand for carbon credits. Røine and Tvinnereim (2009) estimated in March that Annex B countries have a net Kyoto deficit of 544 mtCO2e, down 39% from September 2008.

AAU supply alone could satisfy the entire demand under Kyoto through the end of Phase II, and the current supply of CERs is sufficient to meet demand under the EU ETS.

Unless thepost-Kyoto treaty eliminates the overhang of AAU, my answer is yes.

RGGI funds misallocated

WASHINGTON, March 17 (Reuters) - New Jersey has become the latest state in a regional cap-and-trade market on greenhouse gases to take money meant to support clean energy programs to help ease its budget deficit. "Pain had to be distributed across the board," Elaine Makatura, director of New Jersey's Department of Environmental Protection, said in an interview on Wednesday. She said Gov. Chris Christie has decided to move $65 million from New Jersey's Global Warming Solutions Fund to its General Fund.

New York Gov. David Paterson decided last year to use $90 million from RGGI auctions to help ease that state's deficit.

The auctions have raised more than $580 million.

Summary and conclusion

- The majority of trading is still in the EU ETS. The dominant exchange for screen and OTC trading is the ECX.
- Only the spot market and near-term futures are fully cointegrated.
- Uncertainties about CERs have prevented their prices from sharing a common trend with the EUAs.
- RGGI prices are cointegrated with EU-ETS prices.
- Voluntary CFI prices in the U.S. are cointegrated with EUA, but the EU-ETS convergence probability has fallen by more than 20% since the start of 2010.