The end of the Kyoto Protocol era: What can we learn from the global trade of Emissions Reduction Units applying network analysis?

Raphaela Kotsch^{1,2}, Regina Betz², Peter Schwendner², Jan Abrell³

¹ University of Zurich

²Zurich University of Applied Sciences

³ZEW Leibniz Centre for European Economic Research

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https://snis.ch/projects/designing-effective-regulation-for-carbon-marketsat-the-international-national-and-subnational-levels/



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Overview

Introduction and motivation

2 Background

3 Methodology





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Market mechanisms under the Kyoto Protocol

Kyoto Protocol



• Assigned Amount: Base year GHG emissions * (1 - emission reduction target (%)) * 5 years

• Emissions = anthropogenic greenhouse gases (CO2, CH4, N2O, Industrial gases) from all sectors on the territory of a country (excluding aviation and international ship)

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Market mechanisms under the Kyoto Protocol



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The international carbon market under Kyoto

- At best Kyoto units are zero-sum game for the atmosphere
- Initial idea: Countries with Kyoto commitments invest in cheaper projects in other countries to generate offsets for compliance
 However, the market developed differently:
 - Many countries or companies within the host countries did invest without the direct involvement of foreign entities into reductions projects and sold certificates on the global market
 - National and regional ETS allowed companies to use ERUs for compliance leading to
 - indirect linking of different ETS (Haites 2016)
 - new market participants (companies) with different interests and preferences than countries entered the global market

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Motivation: Focus on Joint Implementation (ERUs)

- Lack of understanding on the functioning of the global market for ERUs
- Entire market from beginning to end can be analysed: JI market is closed, generation of ERUs is over
- Design of JI market closest to potential new carbon market under the Paris Agreement
 - All Parties have reduction targets
 - Different level of ambition in NDCs bears risk for new "hot air" (Schneider and La Hoz Theuer, 2019)

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Issues

- Incentive for countries with AAU surplus to sell ERUs from non-additional or over-credited projects (Kollmuss et al. 2015)
- Governments hold and use ERUs for their compliance even though they do not actively trade as ERUs surrendered by companies in national ETS end up on government accounts
- Quality of certificates and environmental integrity issues related to the origin of certificates will not be considered in governmental compliance decision

Issuance of ERUs



Source: IGES (2020)

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Questionable additionality of JI Projects

Project types	Registered projects	% of ERUs	Additionality	Over- crediting	Inventory inconsist- encies	Overall environ- mental integrity
Spontaneous ignition of coal waste piles	78	26.1%	Not plausible	Likely to be very significant		
Energy efficiency in industry and power production and distribution	164	23.1%	Questionable	Not known	None found	Questionable
Associated petroleum gas utilization	22	13.9%	Not plausible	Likely to be very significant		
Natural gas transportation and distribution	32	9.8%	Not plausible	Some over- crediting likely	None found	
HFC-23 abatement from HCFC-22 and SF_{6} abatement	4	6.4%	Plausible	Likely to be very significant		Questionable
N ₂ O abatement from nitric acid	41	4.5%	Plausible	Unlikely	Largely consistent	High

Source: Kollmuss et al. (2015)

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Literature

- Studies on JI market (Elsworth and Worthington, 2010; Kollmuss et al., 2015; Shishlov, Morel, et al., 2016) have not assessed entire Kyoto period or linked information from different registries
- Network analysis increasingly applied to financial markets. Few studies on EU ETS: Karpf et al. (2018), Liu et al. (2018) and Borghesi and Flori (2018) and non with focus on JI including data outside EU ETS.

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Research question

- What is the effect of international certificates on trading network in regional ETS?
- Which sectors and countries play a central role in the trading network? Hypotheses:
 - Ukraine, Russia and other Eastern European countries with "hot air" play major role as sellers
 - ERUs are used for compliance: there are only few transactions between host country accounts and investing/buying entities
 - Sectors which are either familiar with the project types (e.g. energy industry) or experts in trading (e.g. banks, brokers, wholesale commodity traders) will play a important role as intermediaries

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Network framework

- Network graph $G = (\mathcal{V}, \mathcal{E})$
- Nodes $\mathcal{V} = \{1, ..., N\}$
- Directed links between nodes $\mathcal{E} \subseteq \mathcal{V} X \mathcal{V}$
- Network graph represented by its adjacency matrix $D = [D_{ij}]$, where D_{ij} takes on the value 1 if one edge points from seller *i* to buyer *j*
- Links/edges weighted by trading volume

Centrality measures

Quantifying the role of agents in the network:

- Degree centrality: The sum of in and outgoing trades of one node
- Out-degree centrality: Identify important supplier of ERUs
- *Betweenness centrality*: Measures for each node the number of shortest path that pass through the node (Brandes, 2001). Indicator for key brokers and intermediaries
- *Eigenvector centrality*: Measure of influence on the trading network. Takes into account the connection of nodes to other important nodes
- *Authority centrality*: Measure for an important trader who is strongly linked with many important trading hubs

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The effect of economic activity and location of trader on the role of in the market

- OLS regression analysis to investigate whether characteristics of market participant are a good predictor of traders' importance in the trading network of ERUs
- separate regressions for each centrality measure and both commitment periods

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Data

Registry data

EU ETS

- Transfer data 2005-2018
- About 42,000 registry accounts
- 72,327 ERU transfers

Swiss ETS

- Data on 55.580 transfer between 2007-2018
- About 1,000 registry accounts
- 5,580 ERU transfers

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Firm level information

- Matching with ORBIS database to retrieve NACE Rev. 2 codes on a 4-digit level
- Swiss registry data delivery comes with NOGA 2008 codes on 4 digit level that corresponds to NACE codes

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Project level data

• Each registered JI project receives an unique ID in the International Transaction Log (ITL), as well as a UNFCCC reference number

Data

- Information on project track
- Information on project title, project type, host country available from UNEP and UNFCCC

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Results

Project network



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Results

Project network



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JI network

Table: Network descriptives

	CP1 and CP2	CP1	CP2
Nr nodes	8,450	3,481	6,658
Nr edges	20,972	14,700	6,924
Nr transactions	51,732	21,430	30,302

Results

JI network



Results: Regions and countries



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Results

Results: Sectors



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Conclusion

- ERUs were mainly generated by countries with excess AAUs such as the Ukraine and Russia, which may hint at the "laundering" of "hot air"
- Companies trade through jurisdiction with the minimum legal or regulatory requirements: Long trading chains that involve countries such as Jersey or Switzerland outside of the main issuance countries (e.g. Ukraine and Russia) and surrendering countries (e.g. Germany, New Zealand)
- Financial sector, the information and communication, and the wholesale sector play an important role. CH: energy and commodity traders
- "hot air" finds its way into the system and can have a negative impact on environmental integrity
- When including offsets, quantitative limits in each of the linked markets are important as this helps to ensure supplementary

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Thank you for your attention!

raphaela.kotsch@uzh.ch

https://www.rkotsch.com https://twitter.com/kotschR

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