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

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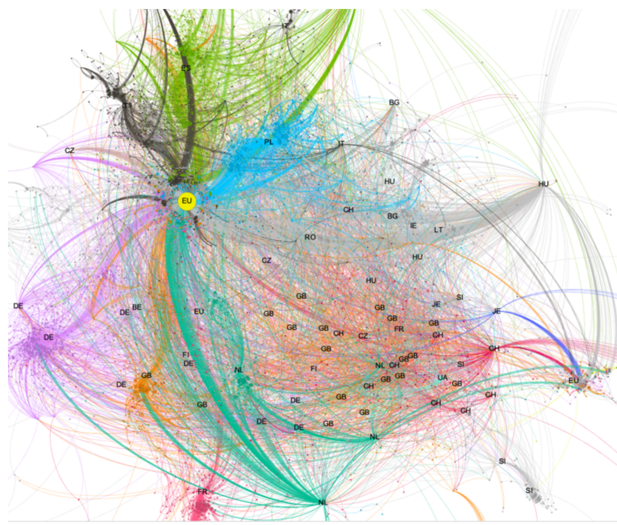
Overview

In this paper, we examine the global carbon market for emission reduction units (ERUs). ERUs are created through Joint Implementation (JI), one of the two offset mechanisms of the Kyoto Protocol. This paper focuses on the structure of the ERU trading network to better understand the role of different actors such as countries and sectors in this global carbon market. The reason we focus on the JI market is threefold: first, there is a lack of understanding of how the global carbon market worked, who participated in trading and who uses the units for compliance. The Clean Development Mechanism and national emissions trading schemes (ETS), such as the European ETS, are much better understood (Borghesi and Flori 2018; Hintermann and Gronwald 2019; Karpf, Mandel, and Battiston 2018) but research on JI is relatively sparse. Second, the period of generating ERUs is over and therefore the complete trading period of a market can be studied for the first time. Third, the lessons learned from JI are relevant to the Paris Agreement because, as with JI, almost all countries will have their own targets - known as Nationally Determined Contributions (NDCs) - and the sale of 'hot air' can arise as the ambition of these NDCs varies widely (Schneider and La Hoz Theuer 2019). It is, therefore, crucial to understand how 'hot air' entered the JI market and who was involved in the trade until the units were surrendered for compliance.

Methods

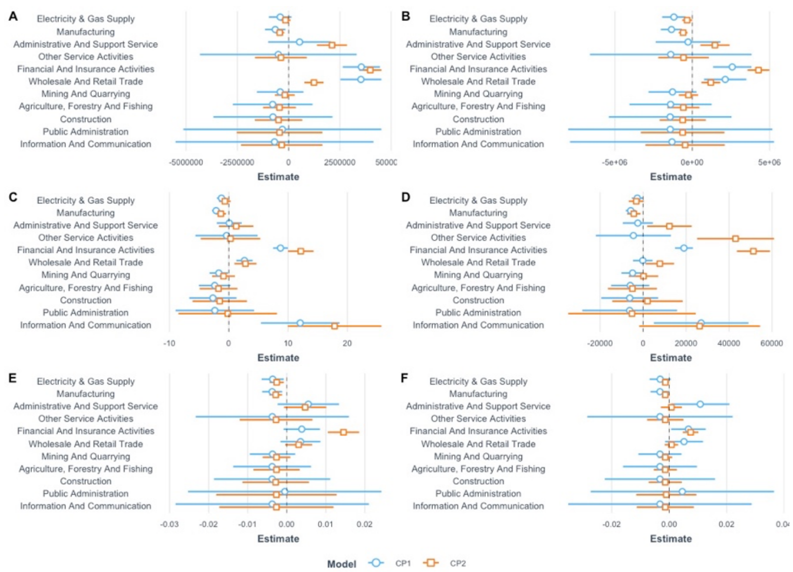


Combining transfer data from the European Union Emissions Trading System (ETS) with data from the Swiss ETS and national registries such as of Ukraine and Russia, we construct a unique dataset of transactions of ERUs at the company level across Annex-1 Kyoto Party countries. The data covers the period from 2008 to 2015 and includes 8,450 traders and more than 51,000 transactions of ERUs. To identify important traders and understand their role in the global trade of ERUs, we apply network analysis techniques. Network analysis techniques have been applied in several areas to study the features of a system (Graham 2019; Jackson 2008).

In a first step, network analysis allows us to represent the trade of ERUs as a directed network graph $G = (V, E)$. V is the set of vertices that represent all traders in the network, which are connected by the edges, the links among them. Thus, $E \subseteq VXV$ represents the set of all directed links between seller and buyer of ERUs. For statistical analysis, the network graph can be represented by its adjacency matrix $D = [Dij]$ where Dij takes on the value 1 if one edge points from seller i to buyer j or the value zero if there exists no trade relationship between these vertices. We weigh edges by the volume traded between seller i and buyer j that results in a weighted adjacency matrix W. In a second step, we compute centrality scores for all nodes, that allow us to identify active traders (degree centrality), important suppliers (out-degree centrality) and user of (in-degree centrality), intermediaries (betweenness and eigenvector centrality) and trading hub (authority centrality). In a third step, we employ regression analysis to investigate whether characteristics of the market participant are a good predictor of traders' role in the trading network of ERUs. To explore the relationship of economic activities and the importance of traders, we ran separate regressions for each centrality measure and both commitment periods.

Results

The results indicate that ERUs changed accounts several times before being surrendered for compliance. In addition to the main issuing countries (e.g. Ukraine and Russia) and the surrendering countries (e.g. Germany, New Zealand), small jurisdictions such as Switzerland and the Channel Island Jersey are also involved in long chains of trade and take on roles as important intermediaries. Further, the financial and wholesale trade sector score high in terms of betweenness and eigenvalue centrality, indicating that they act as intermediaries in the market.



Note: Figure A shows the regression output with dependent variable the weighted in-degree centrality, figure B the out-degree centrality, figure C the results of unweighted degree centrality, figure D the betweenness centrality, figure E the eigenvalue centrality and figure F the estimates with the authority score as the dependent variable. The following sector build the reference group in all regressions: Education, Human Health And Social Work Activities, Water Supply, Sewerage, Waste Management And Remediation Activities, Professional, Scientific And Technical Activities, Arts, Entertainment And Recreation, Accommodation And Food Service Activities, Real Estate Activities, Transportation And Storage.

Conclusions

The policy recommendations we can derive from our analysis are the following: First, “hot air” finds its way into the system, mainly due to national trading of companies and can harm environmental integrity. This is an important lesson learned for the Paris Agreement. This risk may be somewhat reduced by not allowing companies to trade the units and only have governments involved in the market or by restricting it to regulated entities to open accounts and hold and transfer ERUs in their home country. Creating an official marketplace with high transparency and requiring higher standards in international oversight that ensures additionality and stock rules are verified further minimises the risks. A smaller market will also be less prone to gaming and easier to regulate. Finally, when including offsets in national ETS, quantitative limits in each of the linked markets are important as this helps to ensure supplementarity.

References

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