

Market and Trade Network Analysis of the EU Emission Trading System

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Abstract

The European Union Emission Trading System (EU ETS) is the world's largest cap-and-trade system. The observed price instabilities and the oversupply of the allowances are two characteristics that affect the objectives and the efficiency of the policy. In this article, we investigate the impact of storing allowances, i.e. banking, in terms of the price level, transaction volume and importance in the underlying trading network. To that end, we used data from the EU Transaction Log (EUTL) until 2014 in conjunction with a variety of important price determinants. Using a sectoral analysis through the years, we observe that the regulated actors' participation increases in the transaction network, in contrast to the purely financial actors that exhibit an opposite trend. Furthermore, we quantify the relationship between banking and the carbon price by applying multiple regression on the price, considering many possible price determinants, both financial and EU ETS systemic in nature. We claim that after considering these factors, banking is a notable price determinant. Finally, we examine the network of transactions of allowances with respect to the role of financial and regulated nodes. We identify the intermediary role of financial nodes from their significance in the network structure.

Keywords: EU ETS, trading network, Banking, EUA price

1. Introduction

EU ETS [1] is a cap-and-trade system aiming in the reduction of Greenhouse Gas (GHG) emissions. Since its inception in 2005, it has grown, into one of the most significant environmental policy tools globally. In the summer of 2018 EU ETS was running its 3rd phase and covered around 12.000 polluters, consisting of stationary installations and aviation companies. The EU ETS, as a policy instrument, works by capping the overall GHG emissions of the regulated entities. That cap decreases by 1.74% per year. The EU allowance (EUAs) correspond to 1 tone of CO₂ (or equivalent of other GHG). Each regulated entity must surrender an amount of allowances equal to its emissions every year. Some of the EUAs are given for free and the rest are auctioned. EUAs are tradable and bankable. A regulated entity in excess of allowances (due to possible investment in abatement technology) may either sell the excess in the secondary market or store it for future use. For a better functionality of the secondary market, banks and brokers (purely financial entities) were allowed to participate.

According to EU legislation [2], every transaction of allowances has to be recorded. To that end, an electronic accounting system was created. After several structural changes the system has reformed to the EU transaction Log (EUTL). Until 2014, more than 800.000 transactions had taken place.

In our work, data from EUTL [3] was used both to compute the banking for each participating entity and to infer the underlying trading network. In this paper, we consider as entities in the system the participating companies and bureaus and we classify them in three groups: (a) regulated, (b) financial and (c) governmental.

Our goal is twofold. We aim to investigate whether banking of the allowances is a significant allowance price determinant. We find out that the banking of financial entities has a significant effect. The other direction of our research is to identify which class of entities is more "central" in the transaction network and whether any correlation between centrality and entities' type exists. Our findings indicate that regulated entities play less of an intermediary role within the network, compared to their financial counterparts. In this short version of our work, we outline our main findings (for the full version see <https://www.dropbox.com/sh/jh872yl1d4mx765/AAB-VFXpdOK9CWWEdHhPjOBLa?dl=0>).

2. Market and Trade Network Analysis

2.1. The role of Banking as price determinant

In order to test and quantify the relation of allowance storage (banking) with the allowance future price, we considered various factors, suggested by several studies [4], like spot and future prices of carbon, oil, gas, Industrial Production Index, and data from EUTL [3], such as transaction volume. Furthermore, we computed banking, as the amount of allowances that every entity possessed at any given time.

Utilizing the collected and derived data, we investigated the correlation between all the variables. Initially, we eliminated the trends and the seasonality in our dataset and then we applied linear regression considering the EUAs futures price as the dependent variable. By using the Best-Subsets Regression algorithm, we managed to distinguish a significant enough subset of transformed variables. The algorithm compares all possible (linear) models that can be created based upon the chosen variables and finds the one to which data fits best (in terms of adjusted R²). All data used were considered in a

monthly basis, starting from the beginning of Phase II until 2014. The best model for allowances Future Price is described in Table 1. The first 6 rows correspond to the most significant variables along with their coefficients. In our model the banking of financial entities is a statistically significant factor with a p-value less than 0.01. All other variables have a very good p-value as well. The R language was used for the computations.

Table1. Model for EUA Futures Prices

	Estimate	Std. Error	t-value	Pr(> t)	
Constant	-0.00630	0.10896	-0.058	0.9540	
Banking Financial Entities (previous month)	-0.79446	0.37504	-2.118	0.0376	*
Industrial Production Index	0.47037	0.10784	4.362	0.00004	***
Total Transacting Volume Financial Entities	-0.14918	0.06287	-2.373	0.0203	*
Natural Gas Futures Price (previous month)	-0.06995	0.02025	-3.454	0.0009	***
Oil Futures Price (previous month)	-0.01709	0.00709	-2.409	0.0185	*
* p < 0.1; ** p < 0.05; *** p < 0.01					
Multiple R ² : 0.4318, Adjusted R ² : 0.3923					
p-value < 0.01					

2.2. Social Network Analysis

We also used social network analysis (for a similar setting see [5] and [6]) in order to examine which entities play a more “central” role in the system. For each trimester, we constructed the transaction network G(V,E), where the nodes, V, are the transacting firms or bureaus and each edge indicates that at least one transaction between two adjacent entities took place in that trimester.

We used the betweenness centrality measure [7] of a node, which expresses the number of times the node lies in all shortest paths between every pair of nodes of the network, thus revealing its role as an intermediary or how much control it exerts on the network.

In our study, we focus on the following cases: the top 20%, the top 3% and the top 1% of nodes with the highest betweenness centrality. For each case, we calculated the percent composition of each class (regulated, financial, governmental) on a quarterly basis. Our results show that as we move up to the highest centrality nodes, the portion of regulated nodes drops noticeably, whereas the portions of the financial and governmental nodes increase (see Figure 1-b).

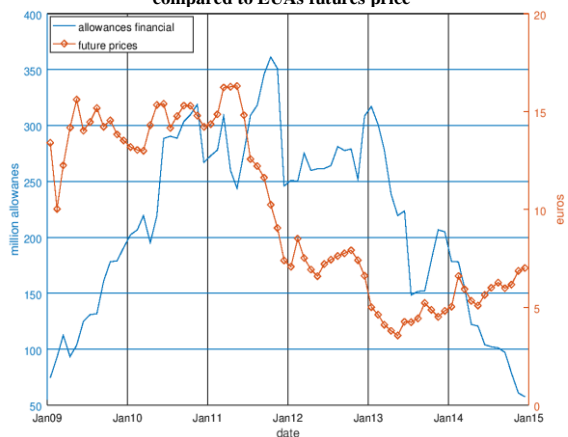
3. Conclusions

In this paper we study the EU ETS and we analyze its operation as a trade network. We show that the banking of allowances is a price determinant by using the Best Subset Regression Algorithm. Finally, by measuring the betweenness centrality of nodes in the trade network, we also show that the financial entities play significant role as intermediaries in the system compared to the regulated entities.

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(a) Allowances stored by financial entities compared to EUAs futures price



(b) Participation of financial nodes in the set of nodes with the highest 20%, 3% and 1% betweenness centralities

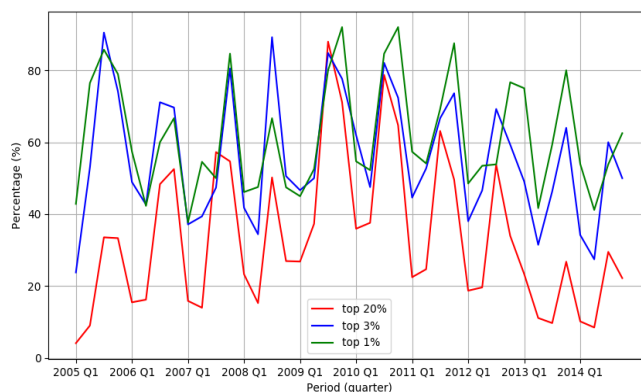


Figure 1. (a) On the left we show the amount of allowances stored by financial entities in a monthly basis, compared to the EUA futures price. (b) On the right we show the increasing percentage of financial nodes in the top betweenness centralities.

References

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