

**Allowance Transactions in the EU ETS
– Evidence from Austrian Companies**

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Our results show that allowance transactions have increased over time and that Austrian companies in the EU ETS tend to mainly acquire allowances in the market. The majority of Austrian companies reported compliance as the main motive for purchasing allowances. However, they stated that the time horizon of buying allowances for compliance purposes has been rather short so far, but some Austrian ETS participants intend to emphasize earlier purchases and consider a longer period in their purchasing strategy. Moreover, our analysis shows that it is a limited number of large companies (trading companies and large energy suppliers) that is very active in the market.

Market actors have gotten accustomed to this new market for emissions over the past 16 years which is illustrated by increasing quantities and volumes traded. Nevertheless, for Austrian companies there is some potential for adapting their trading strategies in order to incorporate the future challenges, primarily for those companies not used to trading on international energy or resource markets.

Keywords

EU Emission Trading Scheme, Data analysis, Survey, Austria, Trading behaviour

1. Introduction

Emission trading has been the key instrument in the EU's climate policy since its introduction in 2005. It covers a total of more than 12,000 installations from industry and energy generation in all Member States, in Austria about 200 installations are included in the scheme. Economic theory emphasizes the advantages of emission trading – the fixed cap on emissions ensures that the environmental target is reached; the option of trading unused emission allowances ensures that mitigation takes place where the most cost-efficient options exist. Since its start in 2005 the EU ETS has been under scrutiny. Regulatory shortcomings especially in the Pilot Phase and the effects of the economic crisis in 2009 led to a pronounced excess-supply of allowances in the market. This, in turn, resulted in very low market prices for allowances over several years, significantly reducing the incentive for firms to invest in emissions reduction measures beyond the low hanging fruit. Whether the EU ETS nonetheless succeeded in fostering mitigation and whether the market for emission allowances is working efficiently have been issues in the scientific debate. This paper contributes to this growing body of literature on the latter aspect by providing an empirical analysis for Austria. Therefore, two approaches are combined – a quantitative analysis of data on allowance transactions and a survey among Austrian firms in the EU ETS on their trading behaviour, motivations, and strategies.

The remainder of the paper is structured as follows: Section 2 starts with an overview of the adaptations of the EU ETS from 2005 until now and the specifications proposed for its further development until 2030. Section 3 summarizes the scientific literature on allowance trading in the EU ETS. Our methodological approach is described in section 4 followed by the description and discussion of our results in section 5. The final section concludes.

2. A brief overview of the EU ETS

The EU ETS covers emissions from the EU Member States¹, Iceland, Norway, and Liechtenstein, and since 2020 is linked with the national Swiss Emissions Trading System. It covers emissions from energy supply and emission-intensive industry², and since 2012 also emissions from internal flights.

¹ In the course of the Brexit, the UK also left the EU ETS.

² In the first two trading phases, CO₂ emissions from four emission-intensive activities were included: energy activities (i.e., large combustion installations, refineries, coke ovens), the production and processing of ferrous metals, activities of the mineral industry (i.e., cement and lime production, glass production and ceramic production), and pulp and paper production. Since Phase 3 the EU ETS also covers CO₂ emissions from the production of non-ferrous metals (primary and secondary aluminium, other nonferrous metals) and from the production of certain chemicals as well as CO₂ emissions from carbon capture and storage. Moreover, perfluorocarbons (PFCs) from aluminium production and nitrous oxide (N₂O) emissions from the production of certain chemicals have also been included.

The design of the EU ETS has been adapted frequently since the implementation of the scheme in 2005, most notably between different trading phases. The first trading phase, the pilot phase, covered the years 2005 to 2007, the second trading phase coincided with the Kyoto Commitment period 2008 to 2012, the third trading phase covered the period 2013 to 2020, and the current fourth trading phase will run until 2029.

In the first two trading phases, emission certificates were allocated to sectors and installations on the national level in the so-called National Allocation Plans following certain EU-wide guidelines. The majority of emission certificates had to be grandfathered, i.e. allowances were distributed based on historical emissions, sometimes including benchmarking elements; the share of allowances eligible for auctioning was limited to 5% in Phase 1 (10% in Phase 2), albeit effective auctioning shares were even lower (Neuhoff et al., 2006). Credits from project-based mechanisms – Emission Reduction Units (ERUs) from Joint Implementation Projects and Certified Emission Reductions from the Clean Development Mechanism – were eligible for compliance within a certain extent (see, e.g., Sterk and Wang-Helmreich, 2008). Allowances issued for the first trading phase could not be used in the second trading phase. This impossibility of banking in combination with a surplus of allocation led to a collapse in prices towards the end of the first trading phase.

In 2009, the EU Climate and Energy Package was adopted, which set the framework for European climate policy until 2020 and included also fundamental changes for the EU ETS.

Starting with Phase 3, an EU-wide cap and allocation process were established. For 2020, an emission reduction target of 21% compared to 2005 was stipulated for the emissions trading sectors. Between 2013 and 2020 a linear pathway towards the achievement of this target was defined, with the cap of the EU ETS being reduced by 38 million allowances per annum which corresponds to a linear reduction factor of 1.74%. For the allocation of certificates more emphasis was put on auctioning³: For the power sector, auctioning has been defined as the only allocation method since 2013.⁴ Sectors that are potentially at risk of carbon leakage continue to receive up to 100% free allocation. Free allocation is based on EU-wide sector specific benchmarks, and the number of certificates being reduced annually according to the linear reduction factor. The remaining 'normal' sectors, i.e., sectors that are not at risk of carbon leakage, received 80% (benchmark-based) free allocation in 2013; this share of free allocation was linearly reduced to 30% in 2020. In addition, two quantity management provisions were implemented in the EU ETS, a provision against excessive price fluctuations and the market stability reserve.

³ Revenues from auctioning are distributed to countries based on their ETS emissions as well as income criteria.

⁴ Albeit with some exceptions for highly efficient co-generation and some New Member States.

In 2018, changes to the design of the EU ETS for the post-2020 period were adopted. Most notably, with the start of Phase 4 in 2021, the linear reduction factor of the EU-wide cap was raised to 2.2% in order to achieve a reduction of greenhouse gas emissions of 43% in 2030 compared to 2005 emission levels in the sectors covered by the EU ETS. In the context of the 'Fit for 55' Package aiming at a 55% cut in total EU greenhouse gas emissions by 2030 compared to 1990, the Commission published also a proposal for changes of the EU ETS. The sectoral emission reduction target for 2030 should be increased to 61%, entailing a higher linear reduction factor of 4.2%, following a one-time reduction of the total cap on emissions by 117 million allowances in 2026.

In order to mitigate “carbon leakage” in EU ETS sectors, allowances should continue to be allocated free of charge to affected industries. For installations required to conduct an energy audit under the Energy Efficiency Directive (European Commission, 2021c; Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on Energy Efficiency, Amending Directives 2009/125/EC and 2010/30/EU and Repealing Directives 2004/8/EC and 2006/32/EC, 2012; Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 Amending Directive 2012/27/EU on Energy Efficiency, 2018), free allocation will only be granted to the full extent if the recommendations of the audit report are implemented. In the medium term, a carbon border adjustment mechanism is supposed to replace free allocation as a means for ensuring competitiveness (European Commission, 2021d). Furthermore, the EU ETS should be extended to shipping⁵. For internal flights, the number of allowances allocated free of charge should be gradually reduced in the process, with the aim of ending free allocation to aviation at the end of 2026. Emissions from flights not covered by the EU ETS are to be offset in accordance with the requirements of CORSIA (European Commission, 2021a). Finally, a separate emissions trading system for buildings and transport has been proposed in the “Fit for 55” Package (European Commission, 2021b).

3. Literature Overview

Research on allowance trading at firm level in the EU ETS comprises two strands: The first strand performs quantitative analyses and is based on transactions data from the EUTL that are published with a time lag of five years. The second strand comprises surveys on firm behaviour in the EU ETS.

⁵ CO₂ emissions from large ships with a gross tonnage of more than 5000 t should be included in the EU ETS in the future, regardless under which flag they sail. If both, the port of departure and destination, are within the EU 100% of the CO₂ emissions are to be covered, in case only one port lies in the EU 50% of the emissions should be covered.

3.1 Quantitative Analyses of Allowance Trading in the EU ETS

Firm trading behaviour and transaction costs in the pilot phase of the EU ETS were analysed econometrically by Jaraite and Kažukauskas (2012) on firm level in 22 EU Member States. According to their results about one quarter of the firms in the EU ETS were sellers of allowances and about one sixth were buyers of allowances. The majority of the selling firms had a net surplus of allowances; 50% of the buying firms, however, also exhibited a net surplus. This suggests that the latter firms did not solely acquire allowances for compliance under the EU ETS but that there might have been an element of financial speculation involved.

Another analysis of firm level trading flows in the EU ETS in the period 2005/2006 by Zaklan (2013) combined data from the EUTL with information on firm characteristics like size, productivity, profitability and ownership structure from the AMADEUS database. His results suggest that firms' participation in allowance trading is determined by a combination of ETS market-specific factors (such as the level of emissions or shortage of allowances) and firm-specific characteristics (like size, company structure or sector). Regarding ETS market characteristics Zaklan (2013) shows that large emitters –tending to show a shortage of allowances (see e.g. Kettner et al., 2008) – were more likely to be active in trading as well as firms with a net shortage of grandfathered allowances. Larger firms were more likely to purchase EUAs, while the probability to sell allowances was not affected by firm size.

The studies described above focussed on transactions between companies regulated under the EU ETS. Betz and Schmidt (2016) take a broader perspective including also companies that are not included in the EU ETS but engage in trading via Person Holding Accounts and apply cluster analysis to identify trading patterns at installation and company level in the first trading phase. Their analysis covers the period from January 2005 to December 2007 and is based on market transfers in EUTL transaction data covering 6,874 Operator Holding Accounts and 729 Person Holding Accounts, and respectively 44,434 market transactions and a transfer volume of 2.9 billion EUAs. Betz and Schmidt (2016) confirm that most participants (98%) were passive in terms of trading; with more than half of participants engaging hardly in trading and one third of the accounts being managed by other accounts of the parent company. By contrast they find that a small share of accounts was more active but show relatively diverse trading behaviour. Passive accounts generally belonged to EU ETS installations (i.e., 92% were Operator Holding Accounts), while the most active accounts were Person Holding Accounts.

Cludius and Betz (2016) assess the role of banks and other financial actors in the first trading phase of the EU ETS combining regression analysis of transaction data, i.e. a probit model with sample selection, with semi-structured interviews of employees of banks and electricity companies. The analysis of the EUTL transaction data covering the period from January 2005 to April 2007 reveals that financial actors and dedicated trading accounts of large ETS companies accounted for about two thirds of EUA trade volume in the first trading period; by contrast,

many regulated entities did not engage in trading at all (see above). Financial entities were involved in allowance transfers accounting for 45% of the overall transaction volume of 3.5 billion allowances; 24% of the total volume was traded by banks, 8% via exchanges, 6% through a dedicated future clearing account and 7% via brokers and other financial actors such as trading houses, trusts, or pension funds. The regression analysis suggests that large companies in terms of emissions were more likely to interact with financial actors, particularly with banks or exchanges. Selling permits via brokers was, by contrast, of higher importance for small companies. Likewise, ETS companies with a dedicated Person Holding Account for trading were more likely to trade permits with banks or exchanges, but not with brokers. As could be expected, ETS companies short of allowances were more likely to acquire permits from financial intermediaries, while companies with surplus allowances were more likely to sell permits to financial actors. Regarding the role of sectors for engaging in trade with financial actors, no clear-cut evidence was found. The analysis by Cludius and Betz (2016) suggests that financial actors like banks have contributed to reducing trading transaction costs in the EU ETS and increased the efficiency of the scheme also by providing other services.

The analysis by Borghesi and Flori (2018) confirms the crucial role of Person Holding Accounts in the EU ETS also for the second trading period. Moreover, they show that comparably little transactions involve Operator Holding Accounts as both buyer and seller. Transactions were mainly conducted among Person Holding Accounts only as well as between Operator Holding Accounts and Person Holding Accounts.

Hintermann and Ludwig (2019) examine trade flows between individual EU ETS participants for the period 2005 to 2013 by using a gravity framework and combining data from the EUTL and the ORBIS database. Their analysis finds robust evidence regarding a home (country) bias. According to this, participants are significantly more likely to trade within national borders than internationally, and also that the volume traded is greater for domestic purchases. These results suggest the existence of transaction costs that are incurred when emissions allowances are traded across borders.

Using complete firm-level transaction record data for the first and second trading periods, Guo et al. (2020) examine the effectiveness of the market incentives that aim at stimulating abatement. By reviewing the correlation between the firms' profits from trading allowances and the emission abatement, they find a positive correlation between profits from trading and abatement and that the correlation has increased over time (from Phase 1 to Phase 2).

Abrell et al. (2021) analyse the impact of companies' characteristics on market participation. They compiled a panel dataset for more than 6000 companies for the years 2005 to 2014 of transactions in the EU ETS, allowance, and verified emissions from the EU transaction log (EUTL) and included company characteristics from the ORBIS database. They use panel econometric methods to assess which characteristics affect companies' trading behaviour. Their results

suggest a strong influence of a company's size, its net position, its sector affiliation, productivity, and location. Particularly, larger companies, energy sector companies (or companies from carbon leakage sectors) and companies exhibiting higher net positions have a higher probability of active market behaviour.

3.2 Surveys of Allowance Trading in the EU ETS

A qualitative survey on transaction costs of Irish firms in the EU ETS was conducted by Jaraite et al. (2010). Eleven of the 27 respondents had engaged in trading in the EU ETS pilot phase (six selling, five buying), the remaining firms did not engage in trading. By the end of Phase 1 three of the five buying companies showed a surplus of allowances compared to their emissions and seven of the non-trading companies also showed a considerable surplus of allowances. The main motive for the firms not to participate in trading was the fact that their allocation had been sufficient to cover their CO₂ emissions and trading had not been necessary. Thus, the survey suggests that neither high transaction costs nor cost-effective abatement opportunities explain the covered entities' reluctance towards trading⁶.

Attitudes and behaviour of Swedish firms included in the EU ETS in the first half of the first trading phase were assessed by Sandoff and Schaad (2009) by a survey. Regarding their primary trading strategy, respondents most frequently stated to trade so that 'the predicted emissions from the first period are always covered'. In addition, survey results showed that mainly allowances were purchased only by the end of the year. The reduction of risk and a minimisation of administrative efforts seem to be the dominant motivations behind these strategies. Sandoff and Schaad (2009) concluded that a continuous pursuit of such a trading strategy would reduce the efficiency of the EU ETS. Stricter emission targets as well as the possibility of banking allowances for subsequent trading periods might, however, help stabilise carbon prices and reduce inefficiencies.

4. Methodological Approach

In this paper we complement quantitative analyses of allowance trading in the EU ETS with a survey among Austrian firms participating in the EU ETS. One focus of our research is the analysis of potential differences between the three trading phases, in particular between Phase 2 and Phase 3 where the design of the EU ETS was considerably adapted.

⁶ Some respondents, however, added that when it had become obvious that they had held sufficient allowances to cover their obligations under the EU ETS by the end of the first trading phase, the price had been too low to consider trading as an option.

4.1 Quantitative Approach

In the European Union Transaction Log (EUTL; until 2012 Community Independent Transaction Log, CITL), compliance data – i.e., information on the allocation and verified emissions per installation, account data as well as data on the allowance transactions are published (EUTL, 2021).

All installations (from energy supply and manufacturing) and aircraft operators covered by the EU scheme are obliged to open an Operator Holding Account (OHA) for stationary installations or Aircraft Operator Account (AOA) in the Union registry. Other account types include Person Holding Accounts (PHAs) and Trading Accounts (TAs) that can be opened voluntarily for trading purposes as well as administrative accounts⁷ held by the EU or its Member States.

In the transaction database, all transfers of allowances between the different account holders are published. In addition to the transferring and the acquiring account involved, this database includes the type of transaction (allocation, surrender, auction, “normal” transfer between accounts), the transaction date as well as the transaction volume, i.e., the number of allowances. In line with the literature (e.g., Abrell et al., 2021; Cludius and Betz, 2020), we aggregate transactions to annual data (and in turn to phases) according to the “trading year”, which runs from May to April of the following year⁸.

For our analysis, for Austria account holder data are matched with transaction data and company level data from the AMADEUS database in order to obtain information on the companies’ background. For the matching, we followed a three-step procedure: First, account data and AMADEUS data were matched using national company registration numbers. For accounts that could not be matched to AMADEUS data via registration numbers, automatised string matching was performed as a second step. In a third and final step, we tried to match the account data with company data manually. The main aim of the matching was to identify which companies belong to the same corporate group in order to be able to distinguish between internal company transactions and effective trading between companies. In addition to the numerical results, we provide a detailed graphical analysis, i.e., a network analysis.

As described above, network techniques have already been applied to study EU ETS transactions by Borghesi and Flori (2018, 2019) focussing on the country level. We apply this method to the company level. In network analysis, systems are represented as a network or graph $G =$

⁷ These accounts are mainly used for the issuance and distribution of allowances (free allocation, auctioning) as well as for their deletion (cancellation, retirement).

⁸ The first trading phase accordingly comprises all transactions completed prior to May 2008, the second trading phase all transactions between May 2008 and April 2013, and the third trading phase all transactions completed after April 2013.

(V,E), with V denoting the nodes or vertices representing the agents in the system and E denoting the edges or relationships between pairs of nodes. In this context, each node hence refers to an account, while the allowance transactions refer to the edges.

We focus on accounts related to companies in the EU ETS, i.e., we omit administrative accounts. The data for our analysis covers transactions completed between the start of the EU ETS in 2005 and April 2016.

4.2 Qualitative Approach

Based on the extensive desk research described above and in Kettner and Kletzan-Slamanig (2022 *fc.*) and the analysis of emission data, we developed a questionnaire for the survey of Austrian companies participating in the EU ETS. The questionnaire included two separate sections: one containing questions about the firms' abatement activities and whether the EU ETS was a key motive for implementing these measures. The second section dealt with the firms' participation in the market for emission allowances. In this context, two specific aspects were addressed: on the one hand changes in their market behaviour since 2005 and on the other hand the impact of tighter (firm level) allocation and allowance prices on the trading behaviour. The results deliver insights on the development of market activities over time, Austrian firms' participation in the allowance market and the relevance of over-allocation for trading.

A series of guided interviews was conducted with representatives of seven companies from various industrial sectors and energy supply. These interviews served the purpose of checking a preliminary survey questionnaire for clarity and comprehensiveness with regard to the research question. The interviewees provided additional information regarding different technological and market related issues the various firms and sectors face. Subsequently the questionnaire was finalized and sent to all Austrian companies participating in the EU ETS. The invitation to participate was sent out twice per mail followed by another round via email. From the list of 121 ETS companies, 91 were contacted. For ETS participants which have a common group parent the questionnaire was sent only to the parent company. Also, some companies with negligible emissions were omitted. In total, 53 of the 91 companies completed and returned the questionnaire, which results in a response rate of 58%.

5. Results

5.1 Quantitative analysis of allowance transactions

Table 1 presents an overview of Austrian EUTL company accounts acquiring allowances from or transferring allowances to other company accounts in the different trading phases. In the EU ETS pilot phase (2005 to 2007) hardly any firm transactions of Austrian companies were recorded, only 58 accounts acquired and 56 transferred allowances during the three-year period. In the second trading phase (2008 to 2012), 492 firm accounts were active. About 300 accounts

received allowances on the national level, 190 accounts acquired emission certificates internationally, and 100 accounts acquired allowances in both national and international transactions. 400 company accounts transferred allowances to another account in the second trading phase, with about 60% of the transfers conducted within Austria. With respect to domestic transactions, two thirds of the accounts acquiring allowances and just below 60% of the accounts transferring allowances exchanged allowances only within the same company. As described above, the former CITL based on national emission registries was replaced by the EUTL in 2012. In the course of this replacement, new OHAs were set up for all installations. Therefore, all allowances held by 'old' operator holding accounts had to be transferred to the new account. As noted already by Abrell et al. (2021), this led to a very high level of intra-company allowance transactions in the second trading phase. Notably, the share of accounts performing intra-company transactions in national allowances in Austria even slightly increased to 73% with respect to acquisitions and 68% with respect to transfers, respectively. Overall, 276 Austrian company accounts acquired allowances in Phase 3 and 206 accounts transferred emission certificates; in both cases about 60% of the accounts engaged in national allowance transactions. Only a small share of Austrian firm accounts – engaged in both national and international transactions.

Table 1. Austrian accounts participating in firm transactions

	All Accounts	Austrian Accounts			Foreign Accounts			Austrian and Foreign Accounts
		only intra-company	only external	both	only intra-company	only external	both	
Austrian Accounts acquiring certificates from								
Phase 1	58	1	4	5	8	35	5	4
Phase 2	492	202	63	36	20	147	24	100
Phase 3*	276	119	28	16	9	97	7	43
Austrian Accounts transferring certificates								
Phase 1	56	0	1	6	6	39	4	5
Phase 2	400	138	59	41	22	114	26	94
Phase 3*	206	90	24	18	13	55	6	42

* Only transactions completed prior to May 2016.

Source: EUTL, Amadeus database; own calculations.

The number of firm transactions in the EU ETS involving Austrian companies as well as the volume of the transactions are summarised in Table 2. In order to make the different trading phases comparable, average annual values are displayed. As noted above, in the first trading phase only a very limited number of companies and respectively accounts engaged in allowance transactions: Four companies performed a total of 79 domestic transactions (i.e., on average 26 transactions p.a.), three quarters of which were external transactions between different

companies. 43 companies engaged in international allowance transactions, conducting a total of 750 transactions (250 p.a.). The majority of these transactions was carried out between different companies, only 15% within the same company. The number of international allowance acquisitions was more than 70% higher than the number of transfers.

In the second trading phase, transactions increased considerably. 78 Austrian companies participated in the transactions. On average 159 national transactions were recorded, more than half of the transactions occurred within the same company. The number of international transactions increased to more than 400, of which approximately 25% were carried out within the same company. International acquisitions again substantially exceeded international transfers.

In the first three years of Phase 3, average annual transactions were below the levels observed for Phase 2. A total of 326 national company transactions was recorded, almost 80% within the same company. In addition, 600 international transactions were conducted (76% external, 24% intra-company). Acquisitions continue to exceed transfers, albeit the gap was reduced to 30%.

The average annual transaction volume increased from 50 million in Phase 1 to 79 million in Phase 2, and then declined moderately in Phase 3 to 66 million. This pattern holds true for all types of transactions disaggregated in Table 2.

Table 2. Firm transactions in the EU ETS involving Austrian companies

	Total	National	Total	International Acquisitions	Transfers
Average Transactions p.a.					
Phase 1	277	26	250	159	92
Intra-Company	46	7	39	32	7
External	231	20	211	127	85
Phase 2	568	159	409	253	156
Intra-Company	196	89	107	75	32
External	371	69	302	178	124
Phase 3*	326	124	201	118	83
Intra-Company	149	101	48	20	27
External	177	23	154	98	56
Average Transaction Volume p.a. (in million)					
Phase 1	50	32	18	12	6
Intra-Company	2	1	1	1	0
External	48	31	17	10	6
Phase 2	79	26	53	33	20
Intra-Company	23	19	5	3	2
External	55	7	48	30	18
Phase 3*	66	32	34	21	13
Intra-Company	30	23	7	5	2
External	35	8	27	16	11

* Only transactions completed prior to May 2016.

Source: EUTL, Amadeus database; own calculations.

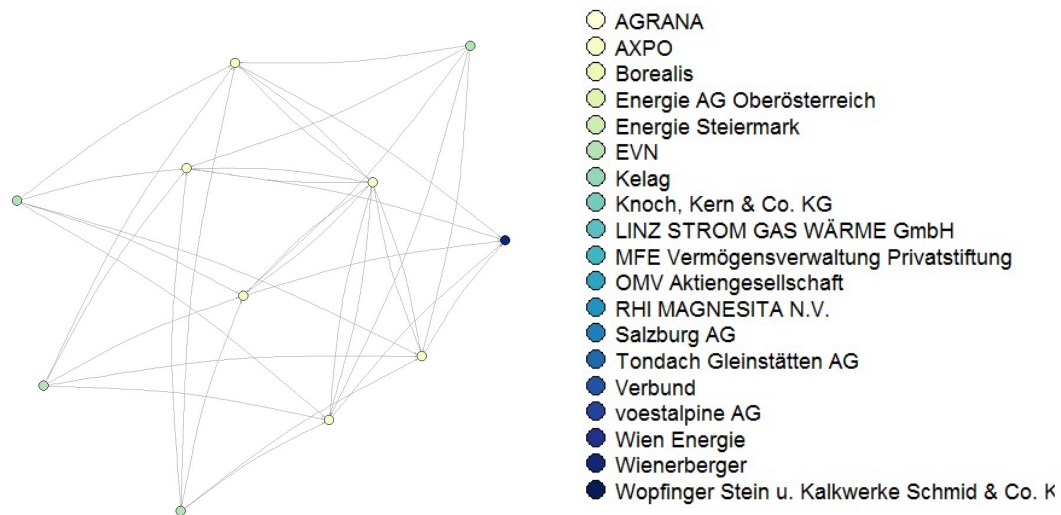
Figure 1 and Figure 2 present additional insights into the allowance transactions of Austrian companies in the three trading phases. Figure 1 displays all domestic allowance transactions between Austrian companies. Every node in the graph illustrates one EUTL account, the connecting lines between the different nodes, the so-called edges, the transactions. Dotted edges represent transactions between the various accounts of the same company, solid edges refer to transactions between different companies. The accounts held by the most important companies in terms of allowance transactions in Austria are coloured. Figure 1 shows that domestic allowance transactions are dominated by a few Austrian companies holding a comparably large number of accounts, which partly reflects the requirement of the EU ETS to hold one separate account for each installation. This holds particularly true for large industrial companies that are responsible for the largest share in Austrian ETS emissions, like the iron and steel producing company *voestalpine*, the chemical company *Borealis*, or *Wienerberger*, a manufacturer of ceramics. In addition, large energy suppliers like *Verbund*, *Energie AG Oberösterreich* or *EVN* also are comparably active in terms of allowance transactions. Finally, a considerable share of transactions also relates to pure trading companies like *AXPO*.

The largest number of participating accounts shows for the second trading phase. As described above, this might at least partly reflect internal allowance transactions necessary due to the transition from the formerly national registries underlying the CITL to the common European registry and the EUTL.

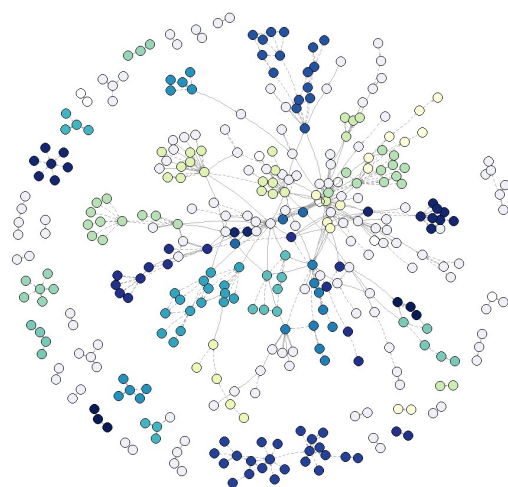
Figure 2 shows the international allowance transactions of the different trading phases involving Austrian companies. In this chart, two aspects are striking. The first refers to the dominant role of large trading companies, most notably AXPO, that carried out external transactions with a large number of different international accounts. The second refers to industry companies, like the ceramics company *Wienerberger* or the food producer *AGRANA*, by contrast that mainly engaged in transactions with foreign accounts of the group. Moreover, it becomes obvious that the trading company AXPO has no longer had a main trading account in Austria in Phase 3 which at least partly explains the decline in the transactions between the second and the third trading phase.

Figure 1. National allowance transactions of Austrian ETS companies

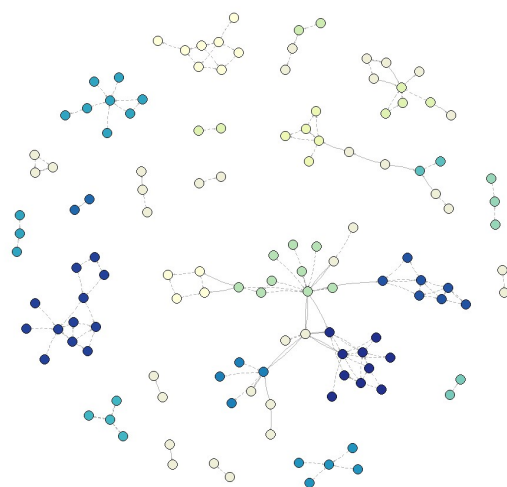
(a) Phase 1



(b) Phase 2



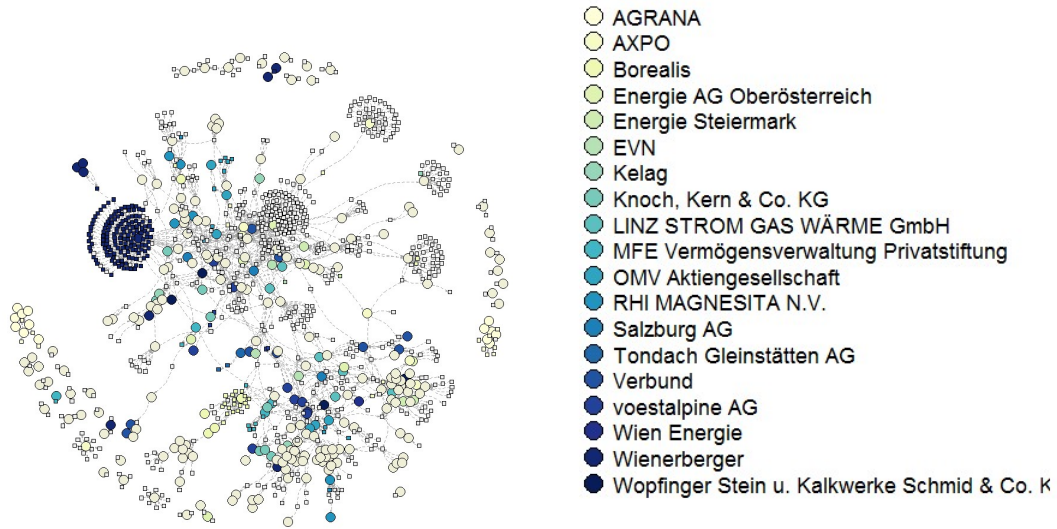
(c) Phase 3



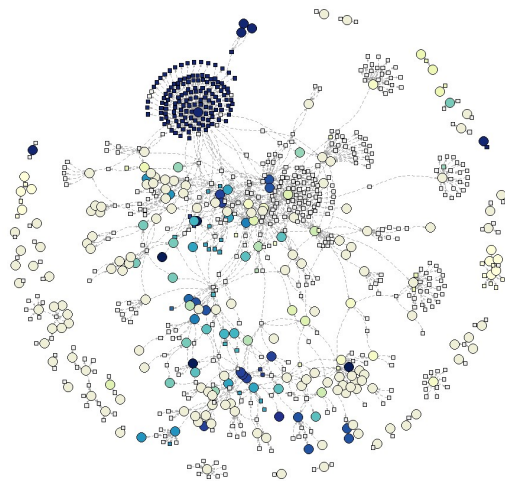
Source: Own calculations based on EUTL and AMADEUS database.

Figure 2. International allowance transactions of Austrian ETS companies

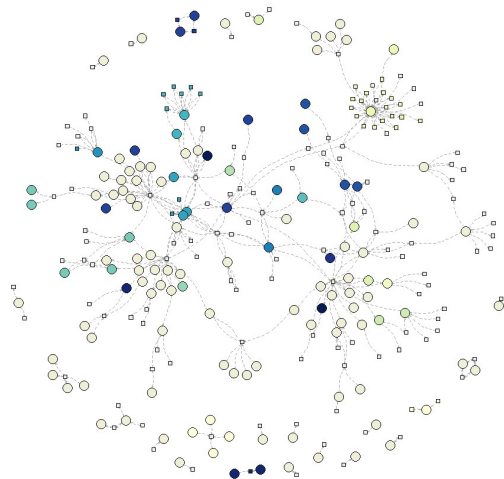
(a) Phase 1



(b) Phase 2



(c) Phase 3



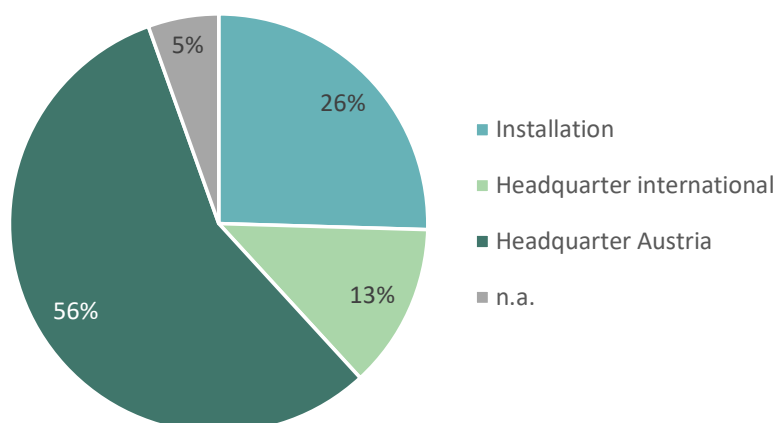
Source: Own calculations based on EUTL and AMADEUS database.

5.2 Survey among Austrian EU ETS participants

The questionnaire sent to Austrian companies in the EU ETS included questions on their trading behaviour, motivations, and strategies. In total 90% of our respondents state that they are or have been buying or selling allowances since 2005. This also reflects answers disaggregated by sectors or emission classes. Of the remaining 10% that are not active in the market the majority is either from combustion or pulp and paper. As the reasons for not trading mainly the lack of necessity due to a sufficient allocation was stated by respondents. Regarding their plans on trading in Phase 4 of the EU ETS 92% intend to buy or sell allowances until 2030.

Figure 3 depicts the distribution of responsibilities for emissions trading in the companies covered by our survey. In more than half of these companies the headquarter in Austria is responsible for trading, for 26% it is managed at installation level. 13% of respondents report the international headquarter as responsible unit for emissions trading.

Figure 3. Responsible entity for trading in the company

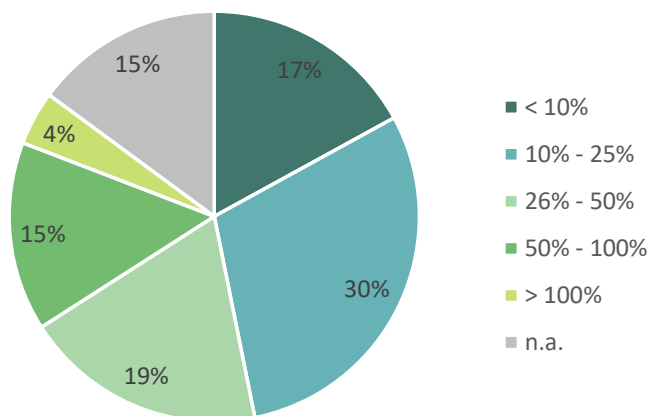


Source: Own calculations.

Figure 4 summarizes the response on the volume of allowances traded relative to the companies' emissions. In our sample nearly one third trade allowances that correspond to 10% - 25% of their emission volumes. Interestingly, a small share of survey participants (4%) state that they traded allowances exceeding the total volume of their emissions. These companies are part of the combustion sector (energy supply) and are characterized by high emissions and a pronounced short position (i.e., allocated allowances are lower than verified emissions). In general, these companies are highly active in trading on energy markets. This result, however, also suggests a trading strategy that is not exclusively determined by compliance but also incorporates profit maximization ambitions. An analysis by Abrell et al. (2021) also shows that companies

from the energy sector and those with high net positions are more likely to be active in the emission allowance market.

Figure 4. Trading volume of emission allowances compared to the total emissions of all EU ETS installations of the company



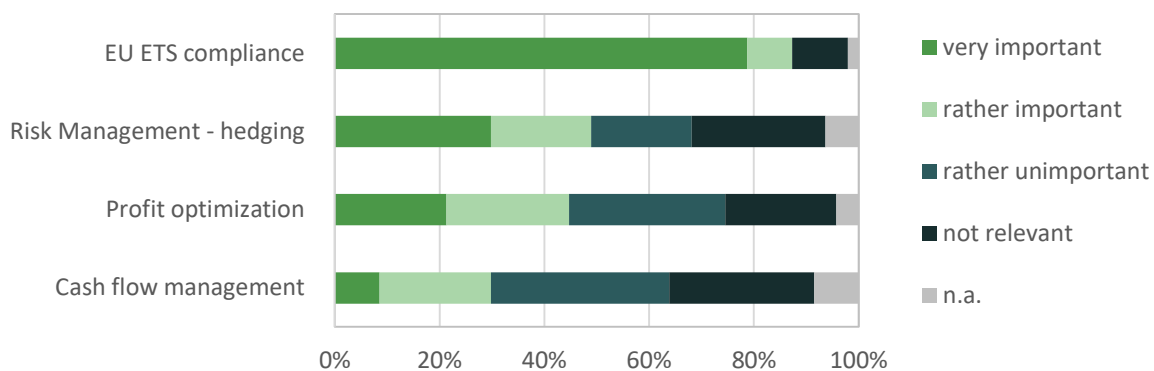
Source: Own calculations

In another question participants in the survey were asked to rank various motives for trading emission allowances (compliance, risk management, profit optimization, cash flow management). Results are depicted in Figure 5 (a). The main motive (across all sectors and emission classes) is compliance, i.e., covering verified emissions with allowances. This motive is regarded as important or very important by 87% of respondents. Hedging against risks is stated by 49% of respondents as rather or very important, profit maximization by 45%. Cash-flow management as motive is important for nearly one third of companies in our sample.

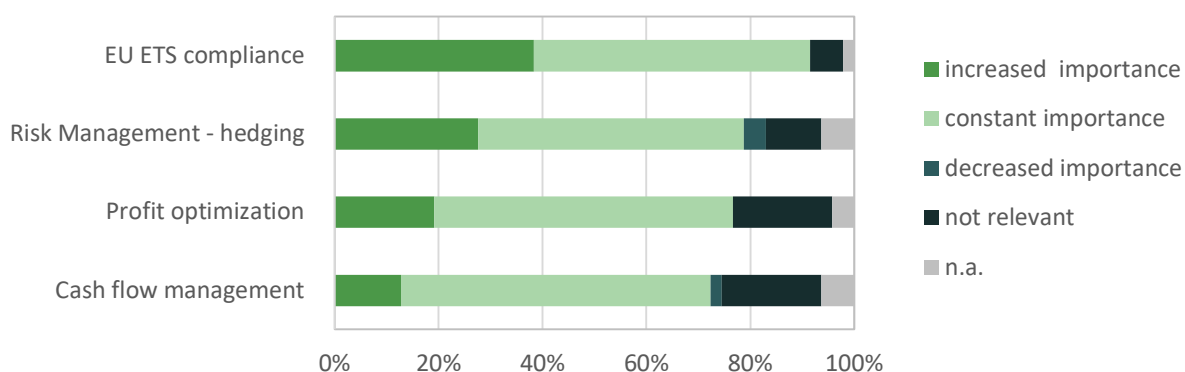
In addition to ranking the motives for trading we also asked survey participants whether the relevance of these motives has changed for them over time (Figure 5 (b)). Mainly (50% to 60% of responses) the motives' importance remained unchanged over time. However, for 40% of respondents the compliance motive has gained in importance, for 28% risk management has become more relevant.

Figure 5. Companies' motives for buying and selling emission certificates

(a) Relevance of motives



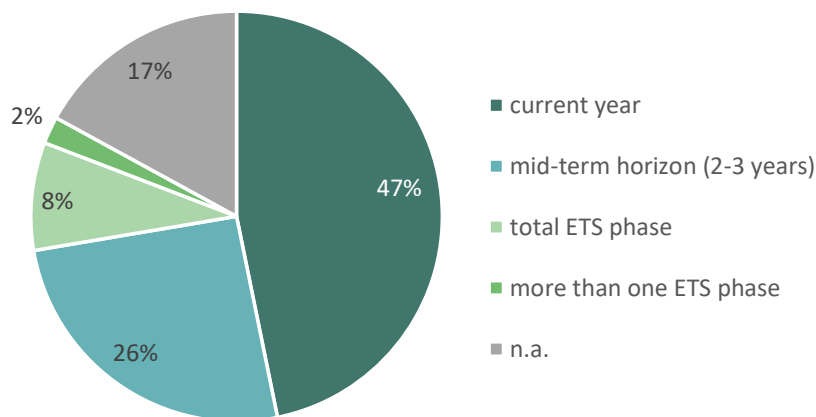
(b) Change in relevance of motives since 2005



Source: Own calculations

As for compliance survey participants were asked for which period or time horizon they usually purchase emission allowances (Figure 6). Answers across sectors and emission classes were relatively uniform. In general, survey participants state that they buy for a relatively brief period – 47% for the current year, another 25% for the next 2 to 3 years. Thus, our results suggest that early purchases to hedge against future price increases are of no particular relevance.

Figure 6. Time horizon for buying allowances for compliance purposes

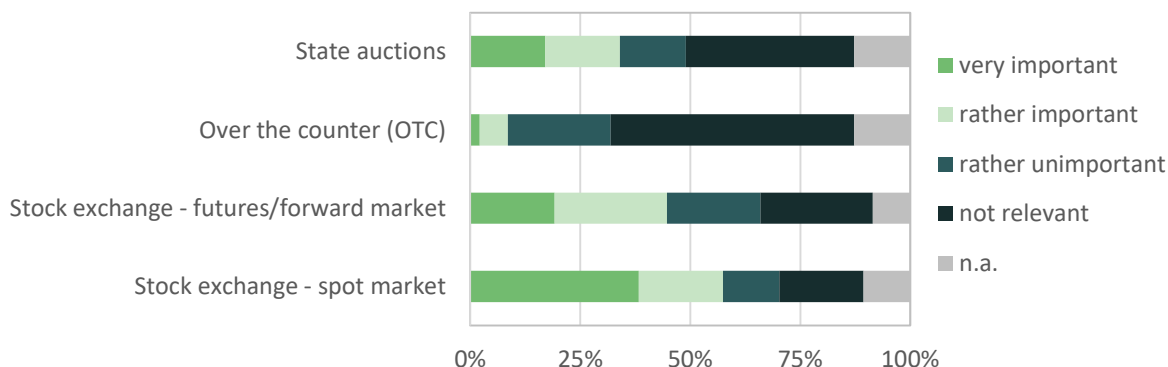


Source: Own calculations

This is also to a certain extent reflected in the answers regarding the importance of various markets for our respondents (Figure 7). Again, answers are quite uniform irrespective of sector or volume of emissions. The majority of respondents regards the stock exchange spot market as very important (38%) or rather important (19%). For the stock exchange futures and forward markets the share for these categories drops to 19% and 26% respectively. OTC trading is stated as very important or rather important market by 17% each. The least relevance is attributed to state auctions of emission allowances. 30% of respondents regard them as irrelevant and another 50% as rather or very unimportant. This finding is contrary to the results by Abrell et al. (2021) who found an increasing share of auctions from 2013 onwards.

Over time respondents also see little change in the importance of the individual market. Around half of responses state an unchanged relevance for all four markets. Spot markets are attributed an increased relevance by 21% of respondents, the futures market by 17%.

Figure 7. Relevance of different markets for the companies



Source: Own calculations

Regarding the question how the transactions are handled the majority of respondents reports to use intermediaries (62%) while only 27% buy or sell allowances directly.

Another aspect of relevance for the assessment of trading behaviour in the emissions market is the frequency of transactions (Figure 8). In this case there is a clear distinction between sales and purchases of allowances. While 80% of respondents buy allowances, this share is only 49% for allowance sales.

In total one third of respondents states that they constantly buy allowances. These firms tend to be from emission intensive sectors and in a short position, i.e., with the need to purchase allowances for compliance in the market. Quarterly purchases seem to be of minor importance (share of 8% of responses). 15% of respondents state to buy on a yearly basis, 23% even less often. 11% of respondents – mainly small emitters – report that they never buy allowances.

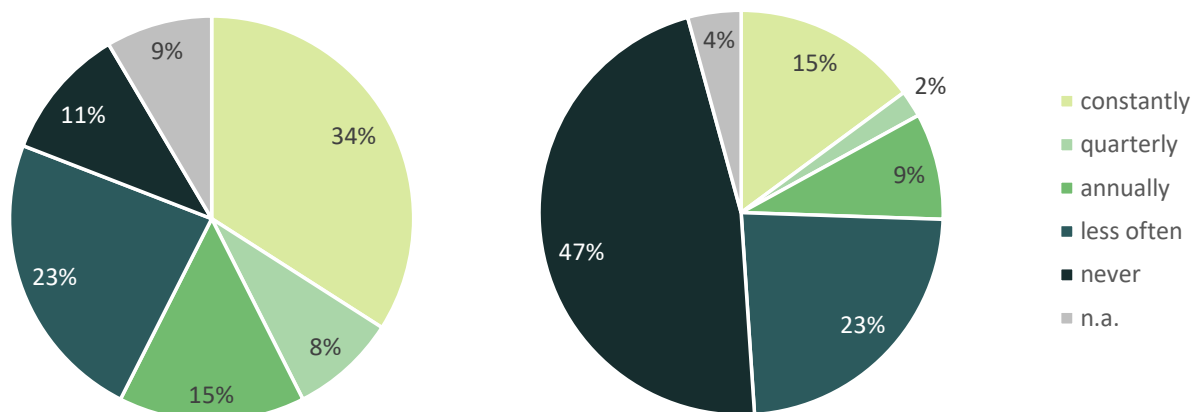
Regarding sales, the share of companies reporting that they never sell allowances rises to 47%. In this case, these firms are to a large extent large emitters in a short position, i.e. without surplus allowance that they could sell on the market. However, those large emitters that sell allowances do so constantly (their share being 35% compared to the 15% of the total sample).

In general, the quantity or volume of transaction has increased over time for a majority of respondents (53%), while for 25% it remained constant and 12% even report a decrease in trading volumes. In contrast, the frequency of trades has largely remained unchanged (reported by 51% of respondents). 32% of respondents indicate a higher frequency while for 9% it decreased.

Figure 8. Frequency of allowance trading

(a) Frequency of allowance purchases

(b) Frequency of allowance sales



Source: Own calculations

Asked whether or not they have used credits from international JI or CDM projects for compliance, 36% report that they have done so up to the allowed maximum. These firms are predominantly again large emitters in a short position. Another 34% declare that they have used some JI/CDM credits, while 25% have not done so.

Last but not least, the survey contained questions on the firms' trading strategy, if it has changed over time, if they plan to adapt it for Phase 4 of the EU ETS and what are the main determinants for the decision to buy or sell on the market. Regarding the latter aspect, 48% of respondents state the market price as main decision criterion. Another 25% indicate the need to cover emissions as decisive aspect for trading and 20% state other strategic considerations.

Three quarters of respondents declare that their trading strategy has not changed over time. The 17% that have adapted their strategy report that they now tend to buy earlier, to be more active and aware of the market and to consider a longer time horizon in their decision making. Also, 72% do not intend to adapt their trading strategy for Phase 4 of the EU ETS. Those that report to plan adaptations also emphasize earlier purchases, a longer time horizon and an increase in trading on futures markets as new focuses.

6. Discussion and conclusions

In this paper the allowance transactions of Austrian firms in the EU ETS are analysed quantitatively using EUTL data as well as based on survey results. The quantitative assessment clearly shows that transactions have increased significantly in Phase 2 compared to the Pilot Phase, and in Phase 3 have slightly decreased again. This decline reflects on the one hand an increased number and volume of transactions caused by the shift from the CITL to the EUTL in

Phase 2. On the other hand, the trading company AXPO has considerably reduced the trading activities of their Austrian accounts in Phase 3. Our survey results also show that trading volumes have increased over time (according to our respondents' perceptions), but trading frequency to a lesser extent. In general, as results from the quantitative data as well as the survey show, Austrian companies in the EU ETS tend to mainly acquire allowances in the market. For the majority of responding companies compliance was reported as the main motive for purchasing allowances. This result is consistent with findings from other empirical studies on this subject.

Austrian companies, however, stated that the time horizon for buying allowances for compliance purposes has been rather short so far and the key aspect for purchase decisions at a certain point in time is the market price. In the context of Phase 4 of the EU ETS, however, a part of Austrian ETS participants intends to emphasize earlier purchases and to consider a longer period in their purchasing strategy.

Both the data analysis and the survey – also conforming with the literature – show that it is a limited number of large companies that is very active in the market. These are on the one hand trading companies and on the other hand large energy suppliers usually active on international energy markets. In contrast, large industrial group companies are highly relevant in terms of their internal transactions.

As noted before market actors have gotten accustomed to this new market for emissions over the past 16 years which is illustrated by increasing quantities and volumes traded. It can be expected that with tighter emission targets and rising prices trading activities will develop dynamically in the coming years. For Austrian companies there is some potential for adapting their trading strategies in order to incorporate the future challenges. This concerns primarily those companies that are not used to trading on international energy or resource markets.

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Appendix: Questionnaire for the Company Survey

• Section A - Measures to reduce emissions in ETS installations

1 Has your company implemented measures to reduce emissions from your ETS installation(s) in Austria since the introduction of the EU ETS in 2005?

- Yes → Please continue with question 2
 No

1a Why has your company not implemented any measures that would have led to an emission reduction of your ETS installation(s) in Austria since the introduction of the EU ETS in 2005?

2 Which emission reduction measures have been implemented by your company in Austrian ETS installations since the introduction of the EU ETS in 2005 or are planned for the future?

Please tick one answer per line

	implemented	in planning	not relevant
Fuel switch to less emission-intensive fossil fuels (e.g. natural gas)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fuel Switch to Renewable Energy Sources	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Energy efficiency measures (e.g. boiler replacement, energy management)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Process optimization (excluding pure energy efficiency measures)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Use of recycled raw materials - circular economy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Decommissioning of installations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Carbon Capture Usage / Carbon Capture Storage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other measure (please specify): _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3 To what extent have emissions approximately been reduced at your ETS installation(s) in Austria since the introduction of the EU ETS in 2005?

Please estimate the average across all ETS installations in Austria.
 Please tick only one answer

- less than 10%
 between 10% and 25%
 between 26% and 50%
 more than 50%
 not specified

4 Since the introduction of the EU ETS in 2005, the measures to reduce emissions from your ETS installation(s) in Austria have ...

Please tick only one answer

- been intensified
 remained the same
 been reduced
 not specified

5 How important were the following motives for the implementation of emission reduction measures since the introduction of the EU ETS in 2005?

Please tick one answer per line

	very important	rather important	rather unimportant	unimportant	not relevant
Cost reduction	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EU ETS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Long-term EU climate goals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Energy efficiency directive	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Financial support measures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other motive (please specify): _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6 Have the motives for implementing emission reduction measures in your Austrian ETS installation(s) rather gained or lost importance since the introduction of the EU ETS in 2005?

Please tick one answer per line

	increased in importance	importance remained the same	decreased in importance	not relevant
Cost reduction	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EU ETS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Long-term EU climate goals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Energy efficiency directive	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Financial support	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other motive (please specify): _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

• Section B - Emission Allowances Trading Strategy

In this section we ask for information about your company's trading strategy in the ETS. If the decision on the trading strategy is not made in Austria or is not only made for Austria, we ask you to answer the questions for the entire company if this is possible for you.

7 Who is primarily responsible for emissions trading in your company?

Please tick only one answer

- Company headquarters in Austria
- Company headquarters abroad
- Individual site
- I do not know

8 Has your company bought or sold emission allowances since the introduction of the EU ETS in 2005?

- Yes → Please continue with question 9
- No

8a Why has your company not bought or sold any emission allowances since the introduction of the EU ETS in 2005?

9 Does your company plan to buy or sell emission allowances in EU-ETS Phase 4 (2021 - 2030)?

- Yes
- No
- I do not know

10 How important were the following motives for buying and selling emission certificates since the introduction of the EU ETS in 2005?

Please tick one answer per line

		very important	rather important	rather unimportant	unimportant	not relevant
EU ETS compliance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Risk Management - hedging		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Profit optimization		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cash flow management		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Financial support		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other motive (please specify): _____		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

11 Have the motives for buying and selling emission allowances increased or decreased in importance since the introduction of the EU ETS in 2005?

Please tick one answer per line

		increased in importance	importance remained the same	decreased in importance	not relevant
Fulfillment of the EU emission requirements - compliance		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Risk Management - hedging		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Profit optimization		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cash flow management		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Financial support		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other motive (please specify): _____		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

12 If emission certificates are/were purchased to meet the EU emission requirements (compliance): For which period does your company usually buy?

Please tick only one answer

- for the current year
- for a medium-term horizon (~ 2 to 3 years)
- for an entire ETS phase
- for several ETS phases
- I do not know

13 How often does your company usually buy emission certificates?

Please tick only one answer

- constantly
- quarterly
- annually
- less often
- never
- I do not know

14 How often does your company usually sell emission certificates?

Please tick only one answer

- constantly
- quarterly
- annually
- less often
- never
- I do not know

15 How do you decide on buying or selling emission certificates at a certain point in time? What is the strategy behind these decisions?

Please describe briefly, if possible.

16 How does your company usually buy / sell emission certificates?

Please tick only one answer

- Via an intermediary (broker, financial institutions, banks)
- Directly
- I do not know

17 How important are the following markets for your company's emission certificate sales or purchases?

Please tick one answer per line

	very important	rather important	rather unimportant	unimportant	not relevant
Stock exchange - spot market	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Stock exchange - futures market	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
State auctions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Over the counter (OTC)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

18 Have the following markets for buying and selling emission allowances increased or decreased in importance for your company since the introduction of the EU ETS in 2005?

Please tick one answer per line

	increased in importance	importance remained the same	decreased in importance	not relevant
Stock exchange - spot market	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Stock exchange - futures market	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
State auctions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Over the counter (OTC)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

19 Has your company used international credits (ERUs, CERs from JI / CDM projects*)?

* Emission Reduction Units, Certified Emission Reductions from Joint Implementations / Clean Development Mechanisms)

- Yes, to a small extent
- Yes, up to the maximum allowed
- No

20 Has your company's trading strategy for buying and selling emission allowances changed over the different EU-ETS phases?

- Yes
- No → Please continue with question 21

20a How has your company's trading strategy for buying and selling emission certificates changed during the different ETS phases?

21 Does your company plan to adapt the trading strategy for buying and selling emission allowances for Phase 4?

- Yes
- No → Please continue with question 22

21a How does your company plan to adapt the trading strategy for buying and selling emission allowances for Phase 4?

22 How high is the trading volume of emission allowances compared to the total emissions of all EU-ETS installations of your company?

Please tick only one answer

- less than 10%
- between 10% and 25%
- between 26% and 50%
- more than 50% to 100%
- more than 100%
- not specified

23 Since the introduction of the EU-ETS 2005, the trading volume of emission certificates in your company...

Please tick only one answer

- has increased
- has remained the same
- has decreased
- not specified

24 Since the introduction of the EU-ETS 2005, the trading frequency of emission certificates in your company...

Please tick only one answer

- has increased
- has remained the same
- has decreased
- not specified

• **Section C - Information About Your Company**

25 What is the legal form of your company?

Please tick only one answer

- AG
- GmbH
- OG
- KG
- GmbH & Co. KG
- Cooperative
- Other legal form (please specify): _____

26 Is your company classified to be at risk of "Carbon Leakage"?

- Yes
- No
- I do not know

27 How many ETS installations does your company have in Austria?

Number: _____

28 How many ETS installations does your company have in Europe (outside of Austria)?

Number: _____

29 Does your company have installations outside Europe?

- Yes
- No

30 In which sector does your company operate?

31 How many employees did your company have at Austrian locations in 2019?

32 What was the turnover of your company in Austria in 2019?

If the financial year of your company does not coincide with the calendar year, please refer to the year in which the financial year of your company ends.

In Mio. € _____

33 Do you have any further comments on emission reduction measures, the EU ETS, or trading strategies in the EU ETS?
