European Union Emissions Markets

Trading Mechanisms and Market Dynamics in the Emission Trading System

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Trade and Investment Strategy

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Overview

- The European Union (EU) Emissions Trading System (ETS) is the world's oldest and largest carbon market
- Operating since 2005, covering $\sim 40\%$ of total emissions made in the EU area as of 2022
- A cornerstone of EU climate policy and a model for other systems

Today:

- Introduce the institutional structure and trading mechanisms of the EU ETS
- Describe primary auctions and secondary markets
- Examine trading behavior of firms and financial intermediaries
- Assess market performance and implications for policy design

Why Study Carbon Markets?

1. **Growing Financial Importance**
   - Cumulative auction revenues is €184B from the begining of the policy in 2005. (€38.8B in 2024 alone)
   - In 2024, one allowance costs €65.22/tCO_2 ($75.13/$tCO_2$) on average.

2. **Corporate Strategy (Policy Compliance Market)**
   - Mandatory for all manufacturing and power sectors (∼8K installations)
   - Scope of the compliance is growing.
     - Maritime was included in 2024, and buildings proposed for 2027.
   - Affects investment and operational decisions.

3. **Market Innovation**
   - Price discovery through multiple venues.
   - Integrated with other regional ETS (e.g., Switzerland, UK)

EU ETS: Basic Framework

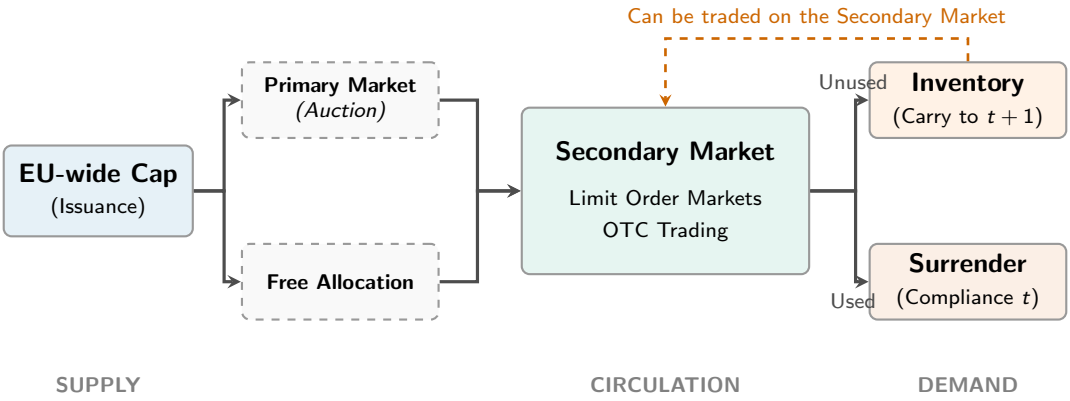
Cap-and-Trade System

- **Cap:** Total allowances are fixed and decline annually by regulatory agency.
- **Trade:** Allowances trade as standardized spot and derivatives across various markets.
  - Primary allocation: Free allocation + Auctions
  - Secondary trading: Limit-Order Markets + Over-The-Counter (OTC) Markets
- **Intertemporal Rules:** Banking allowed; No borrowing.

EU ETS Scope

- **Geography:** 27 EU countries + Iceland, Liechtenstein, Norway
- **Sectors:** Power, manufacturing, aviation (2012–), maritime (2024–)
- **Participants:** ∼8K installations, ∼300 aircraft, and ∼2K maritime operators

Market Structure



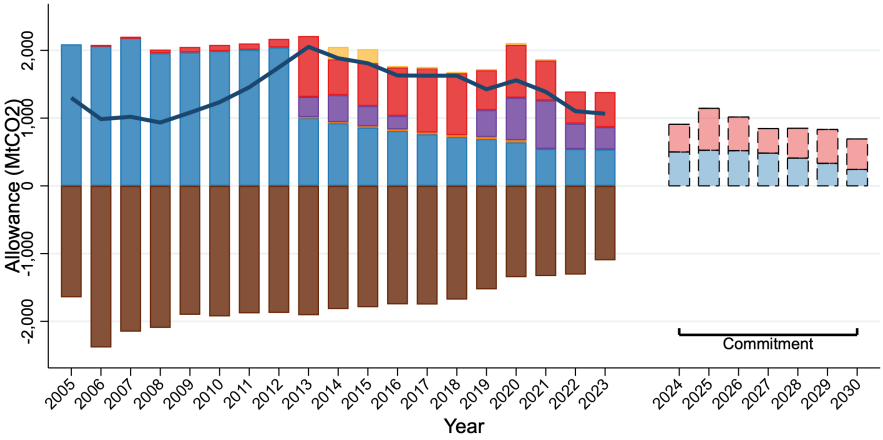
Regulatory Evolution Across Phases

Phase	Years	Cap ($MtCO_2$)	% Auctioned	Carry-over
1	2005–07	2,096	0%	No
2	2008–12	2,049	$< 5\%$	Yes
3	2013–20	2,084 $\rightarrow$ 1,816	$\sim 57\%$	Yes
4	2021–30	1,816 $\rightarrow$ 1,386 (2024)	$\sim 57\%$	Yes

How regulations changed over time?

- **Consistent cap tightening**: 2,096 $MtCO_2$ (2005) $\rightarrow$ 1,386 $MtCO_2$ (2024)
- **EU-wide rules and benchmarks**: Transition from national allocation plans in 2013.
  - Full auctioning for power; benchmark-based free allocation for industry.
- **Rising auction share**: Started in 2010; its share become $\sim 50\%$ in 2024.
- **Introduction of Inventory**: Enabling intertemporal compliance and smoothing from 2008.
- **Scope expansion**: Aviation (2012–), Maritime (2024–).

How allowances have been issued and used?

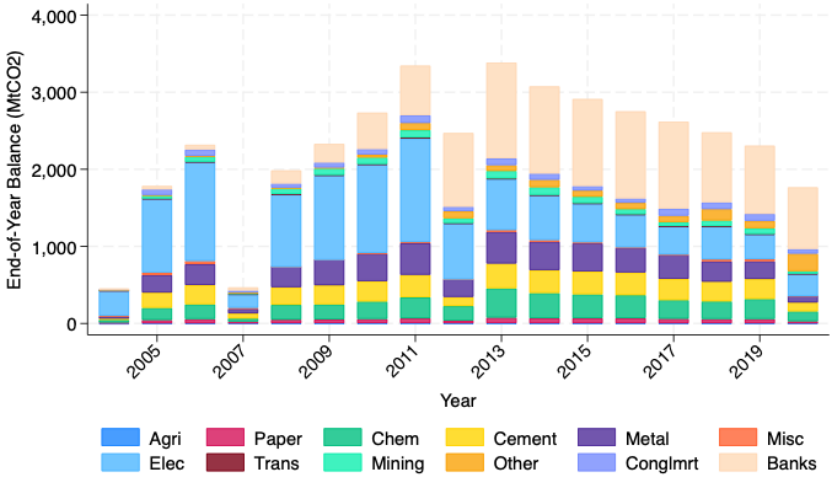


Values for 2024 and beyond (bar with dashed line) represent estimates based on existing policy frameworks.

How many allowances did firms carry over?

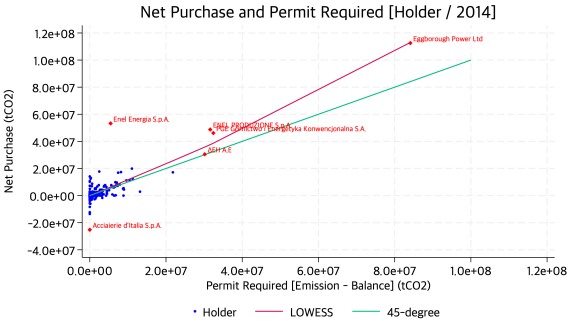
- In the early phases, firms accumulated inventories of allowances.
- However, aggregate inventory levels have steadily declined in later phases across all major sectors.
- This is consistent with earlier periods, where net purchases exceeded immediate compliance shortages.
- Recent data shows firms now purchase only what is needed for immediate compliance.

End-of-Year Inventories: Sectoral contribution over time

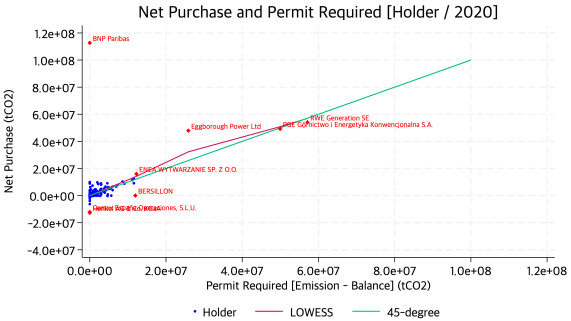


Net Purchases vs Shortages: 2014 vs 2020

2014



2020



Source of Allowances: Free Allocation & Auctions

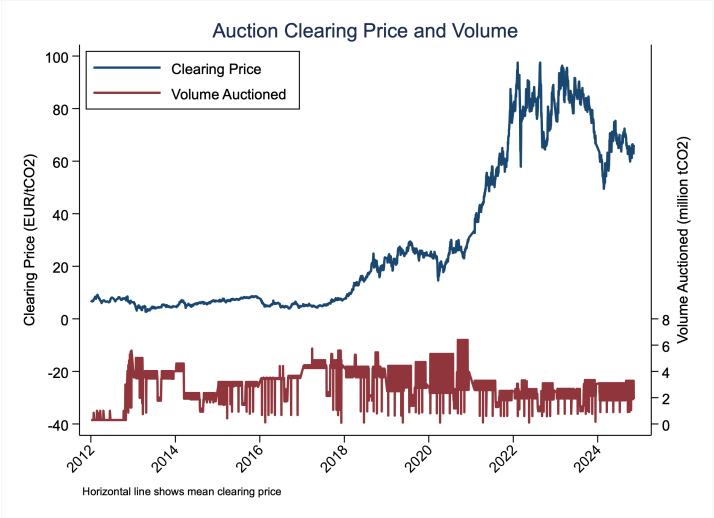
Free Allocation

- Calculated via **historical production levels** multiplied by an **industry-specific benchmark**.
- Set based on the average emission intensity of the top 10% most efficient installations.
  - *Manufacturing:* Eligible for free allocation.
  - *Power:* Full auctioning required; no free allocation.
- Allowances are credited to registry accounts annually in February.

Auctions

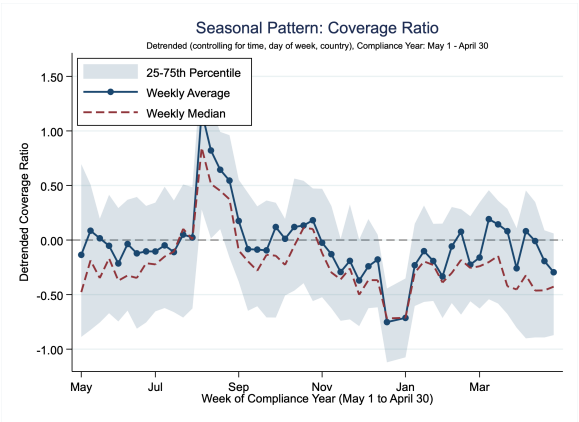
- Single-round, sealed-bid, **uniform-price** auctions.
- Daily auctions conducted on a pre-published calendar.
- Open to compliance entities (emitters) and financial institutions.
- Accounts for $\sim$50% of total allowances.
  - Supply is distributed evenly throughout the year (with reduced volumes in August).

Auction Outcomes Over Time: Price and Volume

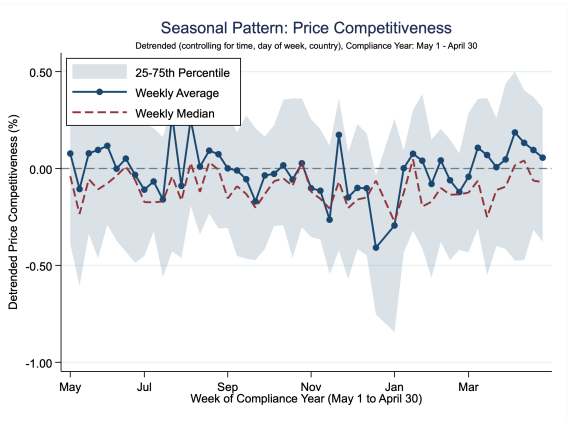


Seasonal Pattern in Auction: Coverage Ratio and Price Competitiveness

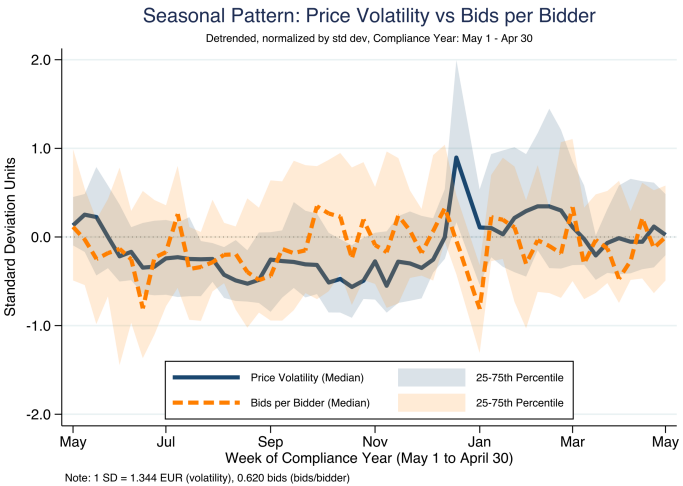
Coverage Ratio



Median vs. Clearing Price



Seasonal Pattern in Auction: Volatility Spikes Around December



Secondary Market: What Is Traded?

Standardized products on exchanges

- **Spot / daily futures**: physical delivery next business day.
- **Futures**: monthly, quarterly, annual contracts (physical delivery in Dec).
- **Options**: calls and puts written on Dec futures.

Secondary Market: Where Do They Trade?

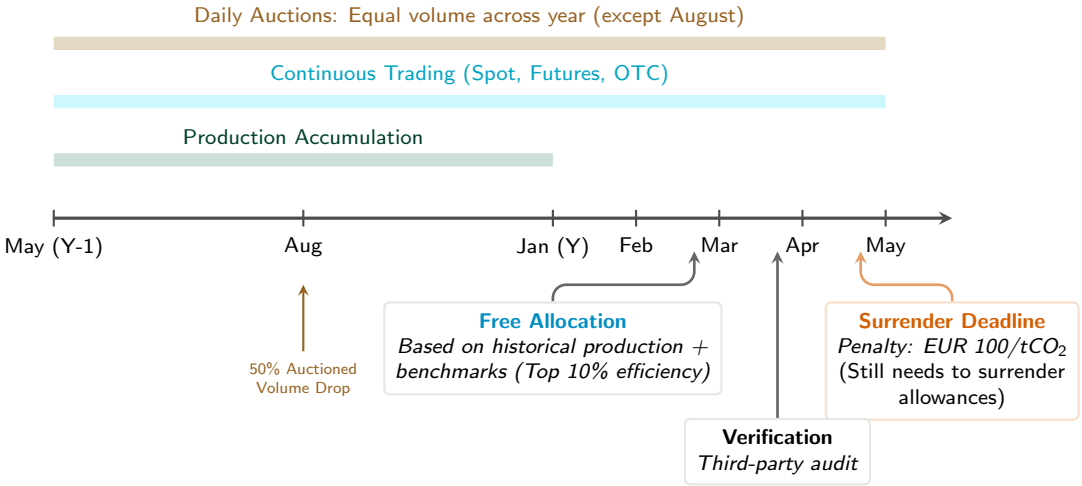
1. Limit-order markets

- Intercontinental Exchange (ICE) accounts for roughly **85%** of exchange volume; European Energy Exchage (EEX) about 15%.
- Continuous limit-order trading with central order book (spot and derivatives).
- Members and non-members face different fee structures.
- Non-members is required to trade via clearing members or brokers.

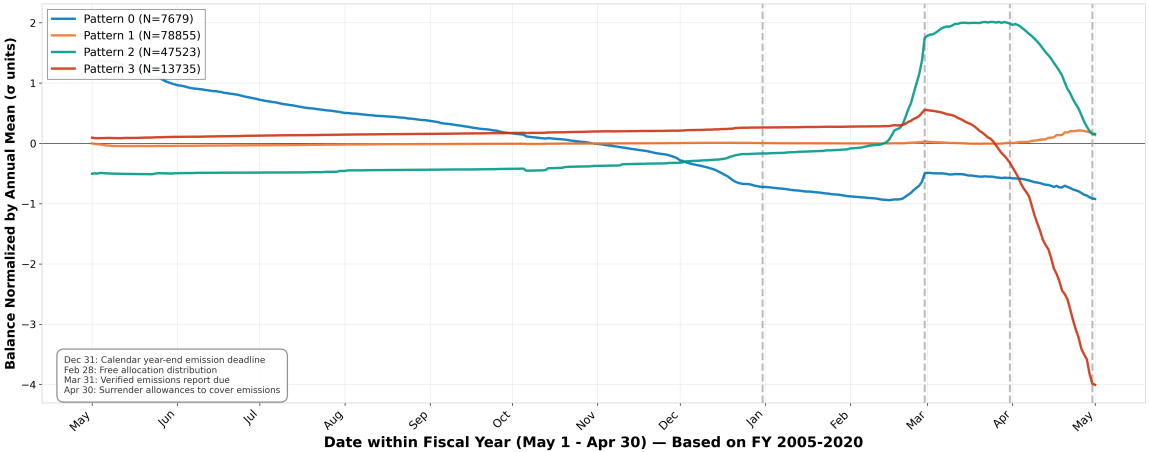
2. OTC markets

- Bilateral trades, often intermediated by banks and brokers.
- Used for block trades, structured products, and tailored risk management.

Annual Compliance Cycle



When firms trade?: Four Distinct Balance Management Patterns



What is the Firm's Optimization Problem?

The Objective: Compliance Cost Minimization

- Firms seek to minimize the **Net Present Value (NPV)** of total compliance costs over the regulation phases.

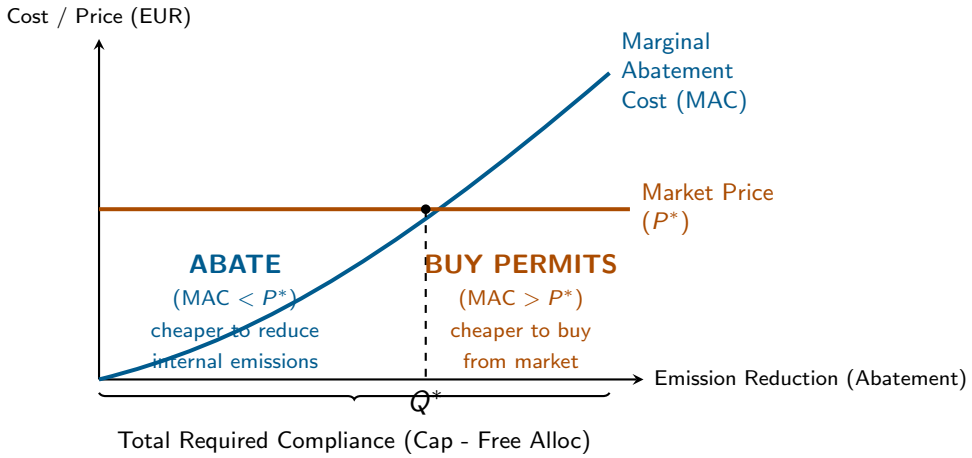
Constraints:

- **Supply Constraint:** The firm receives a fixed (declining) Free Allocation; the rest must be bought or abated.
- **Stochastic Environment:** Future production demand, emission intensity, and allowance prices are **uncertain**.
- **Inventory Constraint:** Carry-over is allowed ($Inventory_t \geq 0$), but borrowing from the future is prohibited.

Decisions:

- **Abate vs. Buy:** Abate internally vs. buy allowances?
- **Inter-temporal Arbitrage:** Save allowances today to hedge against higher future prices?
- **Execution:** Where to trade (Auction vs. Secondary) to minimize transaction costs?

Visualizing the Optimization: Make vs. Buy



Market Efficiency and the Role of Finance

1. **The Benchmark: Complete Market Outcome**
   - In a world with perfect information and no friction:
     - Firms can perfectly hedge risks using derivatives.
     - **Result:** There is **no need for precautionary saving**.
     - **Price Path:** The allowance price should rise at the **risk-free rate** to reflect the "cost of carry."

2. **The Role of the Financial Sector**
   - **Liquidity Provision:** Intermediaries bridge the gap between buyers and sellers, pushing the market **closer to completeness**.
   - **Arbitrage:** Banks exploit price differences across venues (Auction vs. Secondary), enforcing the "Law of One Price."

3. **The Reality: Policy Distortions**
   - In reality, prices deviate from the theoretical risk-free path due to **regulatory interventions**.
   - Government actions create distinct **policy risks** that financial models must account for.

Dynamic Efficiency: Theory vs. Reality