Carbon trading in the European Union

An economic assessment of market functioning in 2021

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Contents

Figures and tables

Executive summary

In the last 18 months the EU has witnessed rapid increases in energy and carbon prices. Although most commentators consider these price increases to be driven principally by market fundamentals, some politicians and stakeholders have pointed to trading by financial institutions as having driven up EU carbon prices and created a carbon price 'bubble'. Notably, some politicians have argued for structural reforms to the EU carbon market, including measures aimed at curbing 'financial speculation', such as imposing position limits on carbon trading.[1]

The well-functioning of a market that enables the trading of EU emission allowances (EUAs) as well as EUA futures and other derivatives is important in the context of the EU's climate objectives given the uncertainties around the energy transition and the need to attract significant new investment.

In light of this, the European Commission has asked the European Securities and Markets Authority (ESMA) to conduct an in-depth analysis of the EU carbon market. ESMA published its preliminary report in November 2021 and is expected to deliver its final report to the European Commission in early 2022.

Commissioned by ICE, this independent report by Oxera has been prepared to inform ESMA's assessment of the EU carbon market. It does so by drawing on a comprehensive review of the market microstructure and environmental economics literature, empirical analysis based on market data, and insights from interviews with market participants.

Carbon trading is a well-regulated market in the EU. In addition to the detailed rules set out in EU directives and regulations, exchanges perform market monitoring and compliance functions to ensure that trust and confidence remains in the market.

- Over time, the trading of EUA futures has developed from an over-the-counter market to a predominately exchange-traded one. This shift has had a positive impact on end-users—as the exchanges have been successful in attracting a more diverse group of market participants, exchange-trading has led to improvements in market resilience, liquidity and price formation.
- The majority of trading takes place between commercial entities seeking to hedge their carbon allowance price and volume risks, and financial institutions and other liquidity providers. Financial institutions participate in the market to take positions or to facilitate trading between counterparties. For example, in November 2021, investment firms accounted for 85% of all short positions and commercial undertakings accounted for 65% of all long positions. While there has recently been an increase in the number of investment funds participating in EU carbon markets, so far the overall size of their positions remains relatively small, representing 4% of total positions in November 2021.[2]

[1] Recent comments have pointed to the detrimental impact of financial speculation on the EU carbon market due to increased risk of manipulation. Throughout this report a distinction is made between speculation and market manipulation. Market manipulation is illegal and impairs market functioning. Speculation plays an important role in ensuring that a trading market functions well.
[2] 'Investment Funds' accounted for 6.4% of long positions, 1.7% of short positions, and therefore 4.05% of all positions in November 2021. See ICE (2021), 'MiFID II Commitments of Traders Report (COT)', for the month of November 2021. For information on the definition of the categories of traders see section 3.4.

- Financial institutions and other market participants willing to take financial positions in the market (typically referred to in the academic literature as ‘speculators’) are integral to the provision of liquidity and price formation. They bring liquidity and have financial incentives to take positions and assume market risk. It is well recognised in the literature on market microstructure that for markets to function well, speculators are needed to take the opposing positions to hedgers to allow the hedgers to reduce their exposure. In providing this liquidity, speculators, as well as arbitrageurs, facilitate, price formation and efficient risk sharing.
- The global energy price increases witnessed in 2021 have highlighted the benefits of hedging and risk management. Firms that are well hedged have continued to operate and serve their customers.
- The carbon price is central to the delivery of the EU’s climate policy, and it is widely recognised that the EUA price needs to be substantially higher than the price levels seen prior to 2021 for the EU to meet its decarbonisation targets.

Where it is suggested that anomalous price movements have occurred, these could be explained by a combination of measures, such as the introduction of more ambitious targets to reduce greenhouse gas emissions, and revisions to the Market Stability Reserve (MSR), as well as changes to other market fundamentals (e.g. abatement costs, including the relative prices of gas and coal). In particular, the MSR—which became operational in 2019 and was revised in 2021—substantially changed the functioning of the ETS by addressing the historical oversupply of allowances.

In sum, the evidence indicates that the EU carbon trading market is functioning well, in the sense that prices are responding to information on supply and demand conditions, not deviating far from market fundamentals (i.e. policy targets, abatement costs, and commodity prices), and the market outcomes are consistent with the overall objectives of EU climate policy. Also, greater participation by financial institutions has improved liquidity and market resilience.

Policy implications

There have been some calls for regulators to impose position limits on EUA futures. While policies such as position limits may help to prevent market manipulation by curtailing the ability of market participants to build up concentrated positions, evidence from other markets suggests that applying inflexible position limits within legislation may be counterproductive, particularly as the market is currently functioning well. Consequently, it would be better to leave exchanges to monitor trading in carbon markets and to take appropriate measures in response to market developments in real time, under the close supervision of the NCAs.

In general, where there is no objective justification for applying remedies such as position limits (i.e. where there is no market failure or concentration of positions in the first place), this policy may distort market outcomes without any beneficial purpose. Similarly, it is important that any policy action does not undermine the success of the EU’s climate policy to date and developments in the market infrastructure relating to carbon trading in the EU in recent years. There may be merit in ESMA improving its ability to monitor market developments. For example, it could be useful to improve the consistency across the EU of the reporting of positions held by different entities, as summarised in the Commitment of Traders reports. Further guidance from

ESMA to reporting entities may help. Market surveillance and monitoring could also be improved via better coordination and data sharing arrangements between the central and national administrators of the Union Registry for the holdings of EUAs and the relevant financial regulators.

There is also value in encouraging the wider use of risk management and hedging instruments among firms exposed to volatility in carbon prices. Failure of energy firms, among others, to manage these risks appropriately could expose households and businesses to unnecessary price shocks during the transition to a low-carbon economy. The impact on consumers of firms' failure to manage these risks also increases the pressure on the authorities to respond in a way that could undermine the EU's climate policy.

Given the planned expansion of the EU ETS in the coming years, it will be important to communicate policy changes clearly and not undermine the work already done. Indeed, after many years of incremental improvements to the EU ETS and the regulatory regime governing the trading of EUAs and the associated derivatives, the EU carbon price is now seen as a global benchmark for carbon trading and a success story that other regions are seeking to follow.

1 Introduction

1.1 Context and objectives of this report

In the last 18 months, the EU has witnessed rapid increases in energy and carbon prices. For example, natural gas futures for physical delivery during Q1 2022 increased from around 18 €/MWh to 125 €/MWh between early January and mid-December 2021—an increase of nearly 600%.[3] Over the same period, price increases of around 50% and 100% were experienced for oil[4] and coal,[5] respectively.

During 2021, the price of European Union Allowances (EUAs) traded in the European Union Emission Trading Scheme (EU ETS) also increased significantly (123%[6]), as shown in Figure 1.1.

Figure 1.1 EU carbon price, 2018–21 (€)

Note: The y-axis shows the EEX EUA primary auction price in €/EUA. Data provided up to 8 February 2022.

Source: Oxera analysis of EEX data.

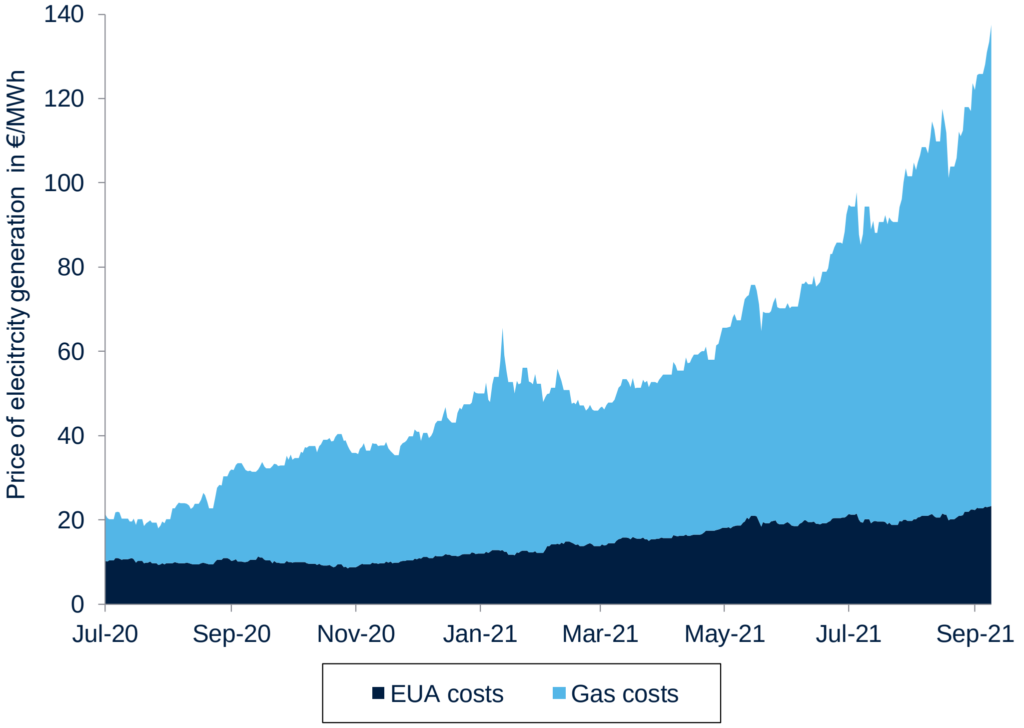
Citing these price increases, some politicians have, on the one hand, raised concerns over the impact of higher energy costs for households as well as

[3] ICE TTF Q1 2022 futures. See https://www.theice.com/products/27996665/Dutch-TTF-Gas-Futures/data?marketId=5806944&span=3 (accessed 30 December 2021). TTF is the leading natural gas hub in Europe, see Oxford Institute for Energy Studies (2021), 'European Traded Gas Hubs: German hubs about to merge', July, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/07/European-Traded-Gas-Hubs-NG-170.pdf (accessed 30 December 2021).
[4] ICE Brent February and March 2022 futures. See https://www.theice.com/products/219/Brent-Crude-Futures/data?marketId=5166945&span=3 (accessed 30 December 2021).
[5] ICE API2 Q1 2022 futures. See https://www.theice.com/products/243/API2-Rotterdam-Coal-Futures/data?marketId=5310599&span=3 (accessed 30 December 2021).
[6] This growth rate is based on the change in price from the EUA primary auction on EEX on 29 January 2021 (the first auction date in 2021) to the primary auction on 20 December 2021 (the last auction date of 2021).

industrial and commercial customers.[7] On the other hand, it is recognised that a substantially higher carbon price, in particular, provides a stronger incentive to switch to renewable energy sources and invest in energy efficiency measures, thereby contributing to lower energy bills and emissions.[8]

That said, as shown in Figure 1.2, carbon costs account for only a small proportion of rising energy costs, with natural gas costs being the main driver for electricity price increases in Europe.

Figure 1.2 Natural gas costs and carbon costs for EU electricity generation, July 2020–September 2021



Note: The y-axis unit is euros per MWh of electricity produced. The chart shows the costs for EU electricity generation from combined-cycle gas turbines. Ember Climate assumes emissions intensity of 0.37tCO_2e/MWh and a plant efficiency rate of 55% (lower heating value). The light blue area shows the share of electricity generation cost that stems from the gas cost, while the dark blue area shows the cost that comes from purchasing EUA allowances.

Source: Oxera analysis of Ember Climate data. Ember Climate (2021), 'Soaring fossil gas costs responsible for EU electricity price increase', 12 October.

Although most commentators consider the increase in energy prices to be driven principally by market fundamentals (i.e. policy targets, abatement costs, and commodity prices), some politicians and other stakeholders have pointed to trading by financial institutions as having driven up EUA prices and created a carbon price 'bubble'.[9] Notably, some member states and MEPs have argued

[7] For an analysis of the impact on households see, for example, Banco de España (2021), 'Recent developments in Spanish Retail Electricity Prices: The Role Played by the Cost of CO_2 Emission Allowances and Higher Gas Prices', Documentos Ocasionales, No 2120. However, it is worth noting that Spain is in a unique position due to its high dependency on gas, limited interconnection levels and relatively high share of consumers with electricity bills connected to the spot price in the electricity market.
[8] European Commission (2021), 'Questions and Answers: Commission Communication on Energy Prices', 13 October, https://ec.europa.eu/commission/presscorner/detail/en/QANDA_21_5202 (accessed 21 December 2021).
[9] See, for example, Reuters (2021), 'German utility Stromio asks regulator to limit EU carbon market speculators', 8 September, https://www.reuters.com/article/eu-carbontrading-idUSL8N2QA4IW (accessed 30 December 2021); Nowacki, M. (2021), 'The chronicle of a crisis foretold: price bubbles in the EU's CO_2

for structural reforms to emission and energy markets, including measures aimed at curbing financial speculation, such as imposing position limits on emissions trading.

In response, the European Commission recently asked the European Securities and Markets Authority (ESMA) to examine the patterns of EUA trading behaviour and the potential need for targeted actions.[10]

ESMA published its preliminary report in November 2021, which found that since 2018, EUA price movements have been largely driven by EU ETS market reforms and the impact of economic fundamentals, notably including the impacts of the Market Stability Reserve (MSR) and the COVID-19 pandemic.[11] For example, as regards the forward curve, ESMA found that the price differential between daily futures prices and December futures prices for contracts expiring out to 2025 remains small, and that the price differential in relative terms (i.e. as a percentage of spot prices) since 2020 has remained stable.[12] Moreover, ESMA found that the increase in the volatility of EUA prices coincided with the introduction of COVID-19-related measures in March 2020. Its analysis indicates that EUA price volatility continues to be somewhat elevated but has remained stable with no discernible trend.[13]

The number and open interest of counterparties participating in the trading of EUA futures and other derivatives have increased significantly. For example, ESMA's analysis highlights that the number of futures position holders increased by around 90% on both EEX and ICE between 2018 and 2021.[14] On ICE, the relative proportions of different types of position holders remained stable during this period, although in 2021, the largest growth in the number of position holders was seen in the categories of 'Investment Firms' and 'Compliance Entities and Other Non-Financials'.[15] ESMA's analysis indicates that the shares of open interest held by different counterparty categories have remained stable.[16]

Oxera understands that ESMA will complete its assessment and publish its final report by the end of March 2022. This independent Oxera report, commissioned by ICE, has been prepared to inform ESMA's assessment of the market.

1.2 Structure

This report is structured as follows.

- Section 2 describes the fundamentals of carbon trading in the EU.
- Section 3 articulates the role of derivatives markets and exchanges in the context of carbon trading.

emissions trading scheme', 6 December, https://www.theparliamentmagazine.eu/news/article/the-chronicle-of-a-crisis-foretold-price-bubbles-in-the-co2-emissions-trading-scheme (accessed 30 December 2021).
[10] European Commission (2021), 'Tackling rising energy prices: a toolbox for action and support', COM(2021) 660 final, p. 12.
[11] ESMA (2021), 'Preliminary report: Emissions Allowances and derivatives thereof', ESMA70-445-7, 15 November, p. 23, https://www.ESMA.europa.eu/sites/default/files/library/ESMA70-445-7_preliminary_report_on_emission_allowances.pdf (accessed 30 December 2021).
[12] Ibid., p. 26.
[13] Ibid., pp. 28–30.
[14] Ibid., p. 34.
[15] Ibid.
[16] That is, 'Compliance Entities and Other Non-Financials', 'Investment Firms', and 'Funds and Other Non-Financials'. See ESMA (2021), op. cit., p. 36.

- Section 4 sets out an economic framework and provides evidence for assessing the functioning of the market for the trading of EUAs, including analysis of market resilience, price formation and liquidity.
- Section 5 explains how trading in derivatives markets affects carbon prices and describes the drivers behind the recent rise in carbon prices.
- Section 6 concludes by summarising the key findings and policy implications of this report.

Further details on the regulatory framework governing the trading of carbon derivatives in the EU are included in Appendix A1. A summary of the literature on the impact of position limits on the functioning of derivative markets is included in Appendix A2.

2 The fundamentals of carbon trading

2.1 The European Union Emissions Trading Scheme

The EU ETS is the cornerstone of the EU's policy to combat climate change and a key tool for meeting emissions-reduction targets cost-effectively. With the Green Deal and the Fit for 55 packages, the EU has set the ambition to cut greenhouse gas (GHG) emissions by at least 55% by 2030, and to become climate neutral by 2050.[17]

The EU ETS is the largest carbon market in the world.[18] According to the World Bank, it is also the most developed and liquid emissions market.[19] In 2020, the EU ETS accounted for almost 90% of global carbon market trading,[20] with four times more trading volume than the next largest carbon market.[21]

Today, the EU ETS covers around 41% of the emissions from 10,000 energy-intensive installations (power stations and industrial facilities) in Europe, covering all 27 EU member states, as well as Iceland, Liechtenstein and Norway.[22]

2.1.1 How does it work?

The EU ETS is a cap-and-trade system.[23] This means that European policymakers set a limit (or 'cap') on the allowable emissions each year, reducing that cap over time so that overall emissions fall across the sectors covered by the scheme. Within the cap, EUAs are allocated directly to qualifying facilities or by auction. The scarcity of EUAs means that they have a value, and companies are allowed to trade those emissions allowances between themselves. (See Box 3.4 for an example of why they might do this.)

After each year, companies with compliance obligations under the EU ETS (hereafter referred to as 'compliance entities') must surrender sufficient allowances to cover their emissions. Under the system, compliance entities must hold allowances corresponding to their carbon dioxide-equivalent (CO_2e) emissions. All else equal, this makes energy generation from burning coal and other fossil fuels, for example, more expensive than renewable or otherwise 'low-carbon' generation based on wind, solar, or nuclear resources.

If compliance entities emit more CO_2e than they have covered by their emission allowances, they face a fine of €100/tCO_2e, as well as needing to purchase the additional EUAs.[24] If a compliance entity produces less emissions

[17] European Commission (2021), '2030 Climate Target Plan', https://ec.europa.eu/clima/eu-action/european-green-deal/2030-climate-target-plan_en (accessed 14 December 2021).
[18] In 2021, China launched its national ETS, becoming the world's largest carbon market in terms of quantity of emissions covered. The EU ETS remains the largest market in terms of revenues. See World Bank (2021), 'State and Trends of Carbon Pricing 2021', https://openknowledge.worldbank.org/handle/10986/35620 (accessed 9 December 2021).
[19] World Bank (2021), 'Carbon Market Could Drive Climate Action', 19 July.
[20] Refinitiv (2021), 'Carbon Market Year in Review 2020', https://www.refinitiv.com/content/dam/marketing/en_us/documents/reports/carbon-market-year-in-review-2020.pdf (accessed 2 December 2021).
[21] Based on 2021 outturns, 15.2 billion EUAs were traded compared to 2.4 billion carbon allowances traded in California (source: ICE).
[22] European Commission (2021), 'Questions and Answers - Emissions Trading – Putting a Price on carbon', https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_3542 (accessed 2 December 2021).
[23] This is different from a carbon tax, which does not regulate the amount of emissions, but rather attempts to disincentivise companies from such activities by increasing the cost base of emitting activities.
[24] European Commission (2021), 'Development of EU ETS (2005-2020)', https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets/development-eu-ets-2005-2020_en (accessed 9 December 2021).

than expected, it can bank spare allowances to cover future needs or sell them to another market participant.

2.1.2 Benefits of a cap-and-trade scheme

A key benefit of cap-and-trade schemes is that they allow emissions to be reduced in the most cost-efficient way possible.[25] An effective carbon price also provides a price signal that incentivises investment in innovative low-carbon technologies. At the same time, firms are incentivised to become more energy-efficient because they can then sell any 'excess' emission allowances into the market.

Such schemes have the additional benefit that—in contrast, for instance, to a carbon tax—the quantity of emissions is set directly by the policymaker. Given that the ultimate goal of climate policy is to limit the quantity of emissions that enter the earth's atmosphere, a cap-and-trade system can be considered as the most outcome-targeted policy instrument available.

Substantial academic literature now exists on the costs and benefits of achieving emissions reductions via the use of markets based on tradable permits like the EU ETS, as opposed to placing limits on the emissions from specific installations directly. For example, an economic analysis of marketable emission permits finds that imposing fixed limits on individual emitters can cost 2–22 times the least-cost alternative, depending on the extent of control applied.[26] The reasons for the cost efficiencies from an exchange-led approach to reducing emissions include that:

1. markets are effective at processing information;
2. market instruments tend to result in emission reductions being undertaken where it is least costly in real terms;
3. market-based approaches generate dynamic gains through responses over time to their patterns of incentives.

Importantly, it is trading that generates the attractive qualities of the cap-and-trade scheme. For direct regulation of emissions at the level of individual installations to achieve the same level of cost efficiency would require the regulator to have knowledge of individual firms' marginal abatement costs.[27] The virtue of market mechanisms is that they incentivise the least-cost emissions-reduction pathway through competition between buyers and sellers.

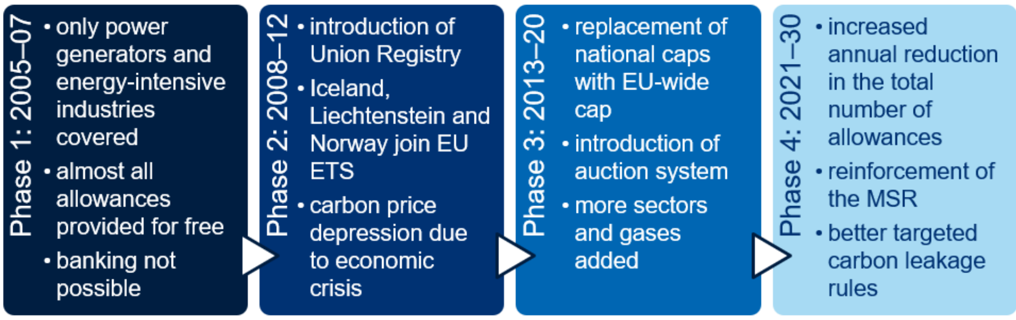
Today, market participants can trade EUAs both in the primary auction and on exchange using futures contracts and other derivatives (discussed further in section 2.4) based on EUAs. This improves the price discovery process, as discussed below.[28]

2.1.3 The evolution of the EU ETS

To assess the functioning of carbon trading markets in the EU, it is important to understand the history of the EU ETS. The scheme has evolved in phases, as summarised in Figure 2.1 below.

[25] For more detail, see Perman, R., Ma, Y., McGilvray, J. and Common, M. (2003), *Natural Resource and Environmental Economics*, 3rd Edition, Pearson, p. 224.
[26] Tietenberg, T.H. (1984), 'Marketable Emissions Permits in Theory and Practice', paper presented at the Conference, Economics of Energy and Environmental Problems, Yxtaholm, Sweden, 6–10 August.
[27] *Marginal abatement cost* is an economic concept—it is the cost to an emitter of reducing an additional unit of environmental emissions.
[28] Price discovery refers to the process of determining the price of an asset in the marketplace.

Figure 2.1 Phases of the EU ETS



Source: Oxera analysis.

- **Phase 1 (2005–07)**: during this phase, only CO_2e emissions from power generators and energy-intensive industries were covered by the EU ETS, and almost all allowances were given to businesses free of charge. The scheme succeeded in setting a price for carbon; however, the issuing of free allowances meant that the EUA price effectively fell to zero in 2007. The banking of allowances between phases 1 and 2 was not possible (i.e. emitters were not able to use allowances issued in phase 1 in phase 2).[29]

- **Phase 2 (2008–12)**: the second phase introduced the Union Registry (replacing the national registries)—which keeps track of the ownership of allowances—and added Iceland, Liechtenstein and Norway to the cap-and-trade region. This second phase was marked by the economic crisis in 2008 and unexpectedly large emissions reductions. This created a large surplus of allowances that also depressed carbon prices throughout phase 2.

- **Phase 3 (2013–20)**: the third phase changed the EU ETS considerably. Banking was allowed such that firms could use phase 2 allowances in phase 3. Moreover, the previous system of national caps was replaced with an EU-wide cap and the auction system for allocating allowances was formalised,[30] with more sectors and gases included in the scheme. Crucially, the MSR was introduced in January 2019 to deal with the surplus of allowances that emerged from the first two phases. The system adapts auction volumes and changes the total number of allowances in circulation (TNAC).

- **Phase 4 (2021–30)**: the EU ETS is now in its fourth phase, which will run until 2030. The banking of allowances was permitted between phases 3 and 4. Key changes in this phase include an increased annual reduction of the total number of allowances, a reinforcement of the MSR, and more targeted carbon leakage rules to accelerate decarbonisation.

In July 2021, the European Commission tightened and reinforced its climate ambitions. While the Green Deal sets out how to achieve climate neutrality in the EU by 2050, the Fit for 55 package established a revised intermediate target of at least 55% net reduction in GHG emissions by 2030. To meet this target, the Fit for 55 proposal mandates that the sectors covered by the EU ETS need to reduce their GHG emissions by 61% by 2030, relative to 2005

[29] See section 2.2 for a description of 'banking'.
[30] Auctions were first introduced as pilots in various countries in phase 2, but auctioning became the default method for allocating allowances in phase 3. See European Commission (2021), 'Development of EU ETS (2005-2020)', https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets/development-eu-ets-2005-2020_en (accessed 17 December 2021).

levels. This represents a significant increase of 18 percentage points compared to the current 43% reduction envisioned.

To achieve the goals set out in the Fit for 55 package, the annual emissions cap needs to be scaled down by a linear reduction factor (LRF) of 4.2% per year, instead of the 2.2% currently envisioned.[31] In addition, the Commission is proposing a one-off reduction of the overall emissions cap by 117m allowances ('re-basing') and the gradual removal of free emissions allowances for the aviation sector by 2027.

In other sectors the number of free allowances has also been reduced over time. Manufacturing, for example, at the start of phase 3 received 80% of its allowances free of charge—this was gradually reduced to 30% by 2020.[32] Since the start of phase 3, power generators have not been granted any free allowances in theory, although some allowances have been issued to incentivise the modernisation of the sector in some countries.

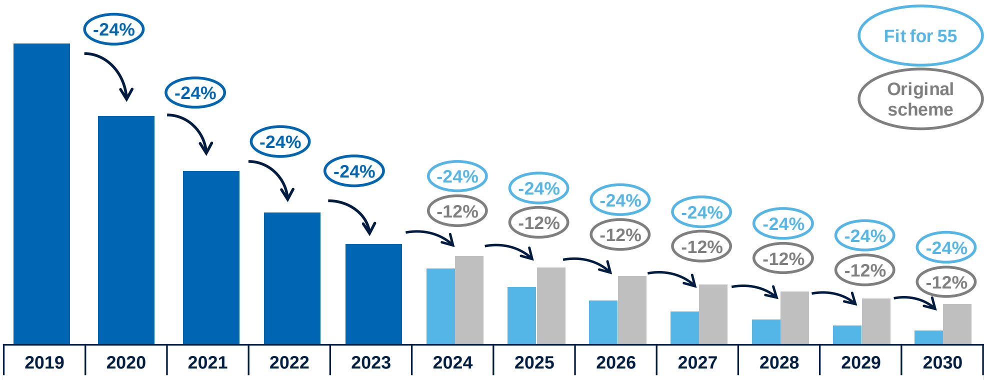
Since the introduction of the MSR, a share of primary allowances have been withheld from being issued and instead placed in the reserve each year. This has the effect of reducing the number of EUAs available to participants in the EU ETS.[33] Figure 2.2 illustrates this reduction over time.

Since 2019, the reduction rate applied, for any given year where the TNAC has exceeded 833 million, is 24%. This rate was due to be replaced in 2023 by a lower rate of 12% (shown in the light grey bars in Figure 2.2). However, under the Fit for 55 package, the Commission has proposed to extend the 24% reduction rate until 2030 (shown in the light blue bars in Figure 2.2). This effectively delays implementation of the 12% rate until 2031. As can be seen from the diagram, if the Fit for 55 package is introduced, the result is significantly fewer surplus EUAs in circulation.

The reduction of allowances and the removal of free allowances are expected to increase carbon prices in the coming years and create strong price signals to drive emissions down.

[31] European Commission (2021), 'Questions and Answers - Emissions Trading – Putting a Price on carbon', https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_3542 (accessed 2 December 2021).
[32] European Commission (2021), 'Free Allowances', https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets/free-allocation_en (accessed 17 December 2021).
[33] The MSR includes an automatic adjustment to the TNAC if it is outside of a given range. Specifically, if the TNAC is greater than 833m, the number of additional allowances placed in the MSR is 24% until 2023 (and 12% thereafter); if the TNAC is less than 400m, a specified number of allowances are released from the MSR. Given that the TNAC was around 1.6 billion in 2021, the MSR is expected to increase, making the TNAC progressively smaller in the coming years. From 2023 onwards, allowances held in the MSR that are in excess of the previous year's auction volume will be cancelled and no longer be valid.
See European Commission (2021), 'Publication of the total number of allowances in circulation in 2020 for the purposes of the Market Stability Reserve under the EU Emissions Trading System established by Directive 2003/87/EC', COM 2021/C 187/02, pp. 1–2, and 5.

Figure 2.2 Illustration of reduction in EU ETS surplus allowances under the Fit for 55 proposals



Note: The diagram illustrates the proposed reduction in the supply of surplus allowances over time under the initial MRS scheme (grey) and the updated proposal in the Fit for 55 proposals (light blue). This surplus is lowered each year by 24% or 12%, thus reducing the number of ETS allowances in circulation. For illustrative purposes, the TNAC is assumed to be constant each year. Further explanation of the MSR scheme can be found at https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=43 (accessed 13 January 2022).

Source: Oxera analysis of European Commission data.

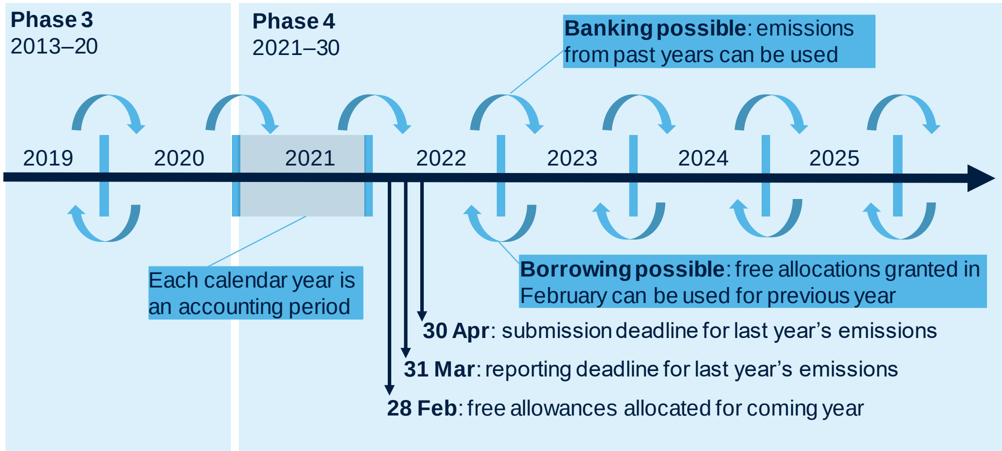
2.2 What are EUAs?

An EUA is an entitlement to emit 1tCO_2e, and is used as the main unit in the EU ETS. EUAs are distinct from EU emissions allowances for the aviation sector (EUAAs), which are allocated only to the aviation industry.[34] However, since the start of phase 4 of the EU ETS, EUAAs are fungible with EUAs from a compliance perspective.

The compliance year runs from 1 January to 31 December. By 30 April of the following year, operators of installations covered by the EU ETS must surrender an EUA for each tonne of CO_2e emitted in the previous year. If a company emitted more tonnes of CO_2e over the past year than covered by its EUAs, it must pay a fine in addition to having to buy the additional EUAs required to comply with the rules. Companies that do not use their allowances can 'bank' them to cover future needs or sell them to other companies, as illustrated in Figure 2.3.

[34] More precisely, 82% are currently granted free of charge to aircraft operators, 15% are auctioned, and 3% are kept in a special reserve for distribution to fast-growing aircraft operators and new entrants.

Figure 2.3 EU ETS compliance timeline



Note: Permits could not be carried forward from the first trading period (phase 1) into the second one (phase 2), but could be carried forward between trading periods thereafter (from phase 2 onwards).

Source: Oxera.

2.3 The auction process for EUAs

The primary market for EUAs is run via an auction. Market operators can compete to run the auction for up to five years as part of a joint procurement process. Currently, the auction is being run by the European Energy Exchange (EEX), as winner of the most recent procurement process.[35]

Auctions take place daily according to a predetermined calendar.[36] Any party that meets the admission requirements (as per Articles 18 and 19 of the EU Auctioning Regulation 1031/20102) can participate in the auction. This provides fair and open access for all participants. Bidders include companies that are obliged to participate in the EU ETS, credit institutions, investment firms, funds, and commodity trading firms without emissions compliance requirements.

Revenues generated from the auctions go to the national governments involved. Between 2012 and October 2021, the revenue generated by participating governments[37] from EUA auctions was €83.7bn. From January 2021 to September 2021 alone, the revenue generated was €18.4bn. The EU ETS Directive requires that member states use at least 50% of auctioning revenues, or the equivalent in financial value, for climate- and energy-related purposes. From 2013 to 2019 around 78% of revenues were used for climate- and energy-related purposes.[38]

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[35] 28 countries (25 EU member states and three EEA EFTA states) auction their allowances on the common auction platform. Germany and Poland have opted out of this platform, as defined by the ETS Directive. However, in practice, Germany and Poland also currently use the EEX platform to auction their allowances. For more detail, see European Commission (2011), 'Common platform for auctioning carbon allowances in the third phase of the EU Emissions Trading System', news article, 21 February, https://ec.europa.eu/clima/news-your-voice/news/common-platform-auctioning-carbon-allowances-third-phase-eu-emissions-trading-system-2011-02-21_en (accessed 30 December 2021).
[36] Auctions take place on Mondays, Tuesdays and Thursdays each week on behalf of the member states and the EEA EFTA states participating in the common auction platform, on Wednesdays on behalf of Poland, and on Fridays on behalf of Germany.
[37] The participating states include member states, the UK, Iceland, Liechtenstein and Norway.
[38] See European Commission (2021), 'EU Emissions Trading System (EU ETS): Auctioning', https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets/auctioning_en (accessed 10 December 2021).

2.4 The role of carbon prices in the transition to net zero

Carbon prices play a central role in driving the investment and application of technologies and alternative energy sources required to mitigate the impact of climate change; and to deliver the commitments of many governments and companies around the world to reduce carbon emissions to net zero.

The economics literature is clear that the most efficient and targeted policy instrument to tackle the carbon emissions 'externality' is a carbon price.[39] Imposing a price on carbon emissions penalises negative externalities according to the 'polluter pays' principle, ensuring that energy producers and consumers internalise the costs of carbon-intensive fuels and activities, and encouraging the use of alternative, lower-carbon energy sources and activities.

2.4.4 How do carbon prices affect electricity generation?

Electricity is generated from primary energy sources such as oil, coal, natural gas, nuclear and renewables (e.g. solar and wind).

In a liberalised electricity market, prices typically vary by the hour, with the price determined by the ranking of available generation technologies and primary energy sources based on their variable costs (including the costs of fuel and carbon, as well as other charges). This ranking is often referred to as the 'merit order', whereby the cost of the most expensive generation technology necessary to meet demand in a given hour sets the market price in euros per megawatt hour (€/MWh).

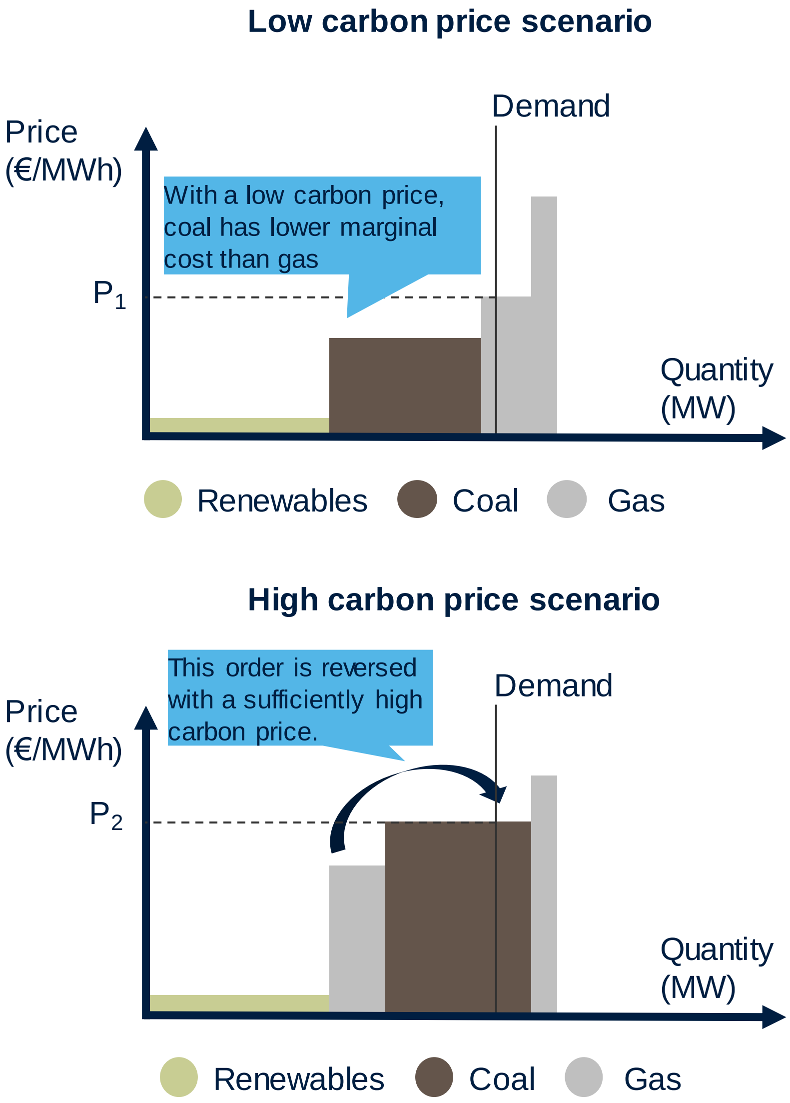
In Europe, the price of the 'marginal' MWh of electricity produced and consumed often results from the competition between natural gas and coal-fired power plants that differ according to their carbon intensity—that is, the quantity of CO_2e produced per MWh of electricity.

The transition to net zero requires the merit order to reflect the benefits of electricity that can be generated with lower or no CO_2e emissions. The carbon price promotes less emission-intensive power generation in the merit order, as illustrated in Figure 2.4. All else being equal—assuming that the relative price of coal and gas does not change—when the carbon price is sufficiently high, a number of gas- and coal-fired plants change positions in the merit order as coal is more polluting than gas.

In the short run, a higher carbon price therefore increases electricity prices for a given demand level and disincentivises generation from more emission-intensive plants, other things being equal. In the long run, a sufficiently high and stable carbon price provides a price signal to incentivise investment in lower-carbon or carbon-free power generation facilities.

[39] The literature also recognises that imposing a carbon emissions price is often a necessary, but not always sufficient, policy response to addressing the market failures. For instance, there are other factors linked to market design and information costs that limit the effectiveness of the price signals and incentives provided by carbon pricing. Therefore it is often important to supplement a carbon pricing framework with other policy measures. See Goulder, L. and Parry, W. (2008), *Instrument Choice in Environmental Policy*, Resources for the Future, April; Perman, R., Ma, Y., McGilvray, J. and Common, M. (2003), *Natural resource and environmental economics*, Pearson Education, third ed.

Figure 2.4 Merit order effect of the carbon price



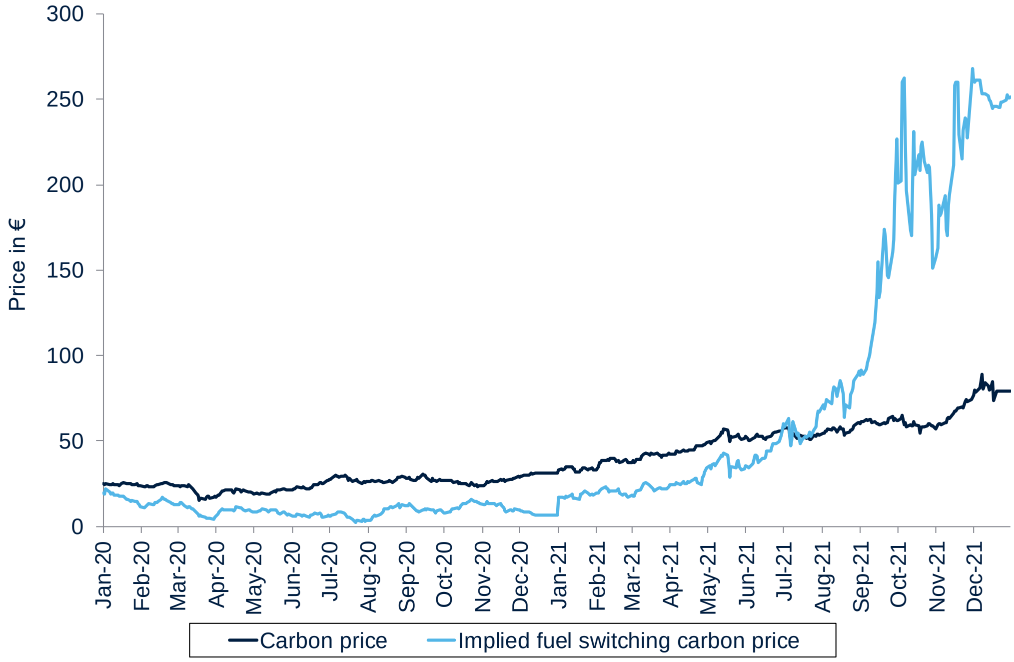
Note: The chart assumes that the relative prices of coal and gas remain constant between the low and high carbon price scenario. As described in the text above, electricity prices are determined by the marginal cost of energy sources in the merit order. The bars represent the marginal cost of each energy source with, for example, the marginal cost of coal increasing from the low to the high carbon price scenario. In both scenarios demand for electricity is set at a fixed level. The market price is determined by the point where the marginal cost of the energy sources in the merit order meets this fixed demand level.

Source: Oxera analysis.

Whereas Figure 2.4 is an illustration of the potential for a carbon price to change the merit order and thereby result in lower emissions, power sector emissions are also influenced by the relative prices of gas and coal. As discussed in sections 1.1 and 5.1.1, the gas price has increased by several times more than the prices for carbon and coal in 2021. As a result, the increase in the cost of gas-fired generation has more than offset the impact of increased carbon prices on coal-fired generation costs. The greater cost competitiveness of coal-fired power generation has in turn led to higher EU power sector emissions despite the higher price of EUAs.[40]

Figure 2.5 shows the EUA price that must be exceeded to incentivise a switch away from coal-fired power production to gas-fired generation given the cost of coal and gas during 2020 and 2021. This implies that in late 2021 EUA prices would have had to reach around €200/tCO_2e to reduce coal-fired generation further.

Figure 2.5 Front-year EUA and implied fuel switching EUA prices



Note: The implied EUA price that would lead to fuel switching from coal to gas is calculated based on the following assumptions: efficiency of gas plant = 40%, efficiency of coal plant = 56%; emissions intensity of coal plant = 0.337tCO2/MWh thermal; emissions intensity of gas plant = 0.221tCO2/MWh thermal.

Source: Oxera analysis based on data from Bloomberg.

It is important to note that the EUA price is not the only measure that can reduce emissions from coal-fired generation. Indeed, several EU member states have planned the early closure of coal plants to ensure phase-outs in the 2020s and 2030s. Meanwhile, the pace of reduction in emissions and abatement costs in the electricity sector will continue to influence the EU ETS price alongside the developments in other industries covered by the EU ETS.

2.4.5 Are EU carbon prices on track to deliver net zero?

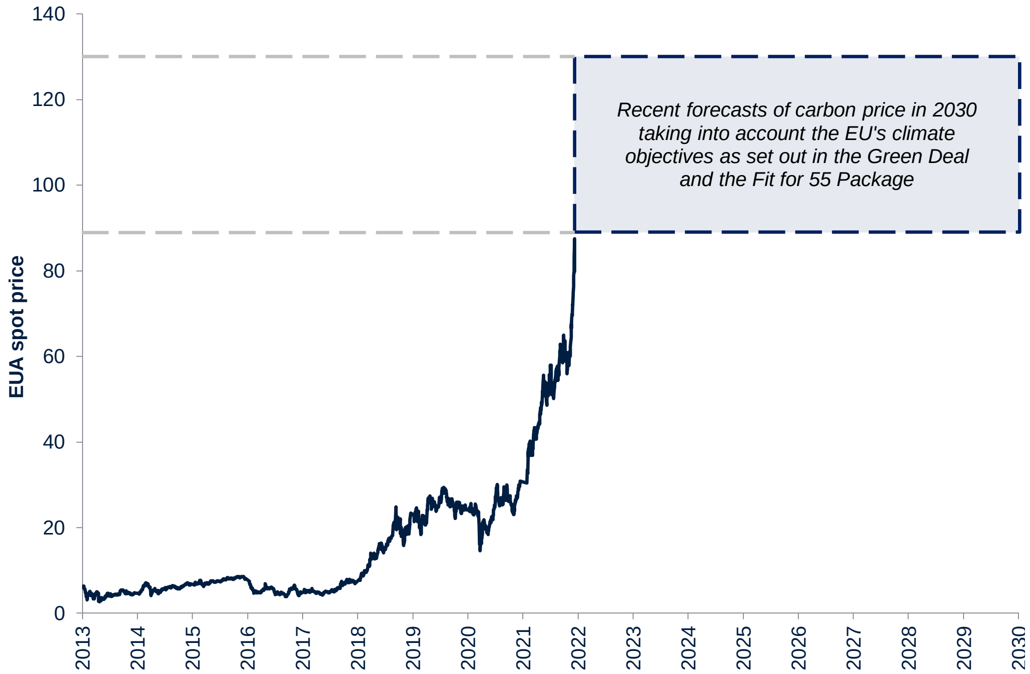
In the context of the recent spike in EU carbon prices, a relevant public policy question is whether the current carbon price is consistent with the EU's decarbonisation targets.[41]

[40] In Q3 2021, the carbon footprint of the EU power sector rose by 1% compared to Q3 2020. The European Commission expected carbon emissions to rise in 2021 due to high commodity prices, especially gas, which triggered greater use of coal-fired generation to the detriment of gas-fired generation, in spite of high carbon prices. See European Commission (2022), 'Quarterly report on European electricity markets', Vol 14, p. 3.
[41] The Fit for 55 package suggests that the sectors covered by the EU ETS would need to reduce GHG emissions by 61% on 2005 levels by 2030.

The IMF has stated that the carbon price needs to be US$75 globally to keep global warming below 2°C.[42] In a similar vein, the new German coalition government has stated its intention to introduce a carbon price floor of €60/CO_2e. The OECD has estimated that the carbon price would need to be €120/$_t$$CO_2$e by 2030 to meet the objective set out in the Paris Agreement of decarbonising by 2050.[43]

Recent forecasts indicate that the current price level is well within the trajectory that is expected and required to meet the EU's climate objectives. For example, ICIS, a market intelligence firm, and research institute, PIK, are forecasting prices to rise to between €90/tCO_2e and €129/tCO_2e by 2030. Platts Analytics is forecasting EUAs to reach €100/tCO_2e by 2030, largely driven by the tightness from implementing the Fit for 55 EU ETS proposals.[44]

Figure 2.6 EU carbon price history and market forecasts for 2030



Note: The y-axis unit is euros per tonne of CO_2e. Recent forecasts from ICIS and PIK expect EU ETS prices to range between €90/tCO_2e and €129/tCO_2e in 2030.

Source: Oxera analysis based on EU ETS auction prices from Bloomberg, and price forecasts from ICIS and PIK. Euractive (2021), 'Analyst: EU carbon price on track to reach €90 by 2030', 19 July; Pietzcker, R. (2021), 'Tightening EU ETS targets in line with the European Green Deal: Impacts on the decarbonization of the EU power sector', *Applied Energy*, **293**:1 July.

As part of the Fit for 55 proposals, the Commission is proposing to expand the EU ETS to cover new sectors.[45] Under its proposal, emissions from maritime transport will be included in the existing EU ETS, while emissions from fuels used in road transport and buildings will be covered by a new, separate, EU-wide emissions trading system. The expansion of the cap-and-trade systems

[42] Perry, I. (2021), 'Five things to know about carbon pricing', International Monetary Fund.
[43] OECD (2021), 'Effective Carbon Rates 2021', p. 4, https://www.oecd.org/tax/tax-policy/effective-carbon-rates-2021-highlights-brochure.pdf (accessed 17 December 2021).
[44] S&P (2021), 'Spotlight: EU carbon price strengthens to record highs in November', 8 December, https://www.spglobal.com/platts/en/market-insights/latest-news/energy-transition/120821-spotlight-eu-carbon-price-strengthens-to-record-highs-in-november (accessed 15 December 2021).
[45] 'Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EU) 2018/842 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement, COM(2021) 555, final, 14 July 2021.

highlights that the carbon pricing signals will become even more important in the future. The impact on the price of EUAs of this expansion will depend largely on whether new sectors can use EUAs for compliance and the net supply–demand balance of these sectors. The carbon prices of the different sectors will align if units from different sectors are fully fungible. Assuming that the abatement costs in new sectors are higher, the inclusion of these further sectors can be expected to lead to higher EUA prices.

In sum, the discussion above indicates that while the recent price changes have been significant, the levels still fall well within the ranges that might be expected in the period up to 2030.

3 What is the role of derivatives and derivatives exchanges in the context of carbon trading?

3.1 Derivatives in carbon markets

A derivative is a financial contract whose price depends on, or is derived from, the performance of an underlying asset, benchmark, commodity, or other instrument, and through which the associated financial risks can be traded between parties.

For the purposes of this report, we are interested in contracts derived on the price of EUAs as the underlying variable, and particularly the following.

- **EUA futures**. These are agreements between two parties to buy or sell an EUA at a certain time in the future for a certain price. These are electronically delivered contracts—a contract that is held up to its expiry results in the physical delivery of EUAs within the Union Registry. Futures are exchange-traded derivatives.
- **EUA options**. These are traded both on exchanges and over-the-counter (OTC). The differences between exchange trading and OTC trading is explained more in section 3.2. A call (put) option gives the holder the right to buy (sell) the underlying EUA contract at a certain date for a certain price (known as the 'exercise' or 'strike price').
- **EUA swaps, EUA forwards and other bespoke derivative contracts based on the price of an EUA**.[46] These contracts are typically privately negotiated with financial institutions and traded OTC.

Box 3.1 describes the main product characteristics of EUA derivatives traded on ICE.

[46] A swap is an agreement to exchange cash flows in the future according to a prearranged formula. A forward is a contract that obligates the holder to buy or sell an asset for a predetermined delivery price at a predetermined future time.

Box 3.1 Characteristics of EUA derivatives traded on ICE

EUA futures

- Contract size: one lot of 1,000 EUAs (i.e. 1,000tCO_2e). Minimum trading size: one lot.
- EUA futures are deliverable contracts where each clearing member with a position open at cessation of trading for a contract month is obliged to make or take delivery of EUAs to or from a trading account within the EUA delivery period. The expiry date is the last Monday of the contract month.
- The EUA delivery period is the period starting at 09.00 London Local Time (LLT) on the business day following the last day of trading of a contract and ending at 15.00 (LLT) on the third business day following that last day of trading.

EUA options

- The EUA Options Contract is an option on the EUA Futures Contract. Upon exercising the option at expiry, one lot of EUA Options becomes one lot of EUA Futures Contracts.
- EUA Options are European style, such that In-The-Money options are automatically exercised upon expiry. In-The-Money options upon expiry cannot be abandoned and both counterparties must honour their leg of the trade. Upon expiry, At-The-Money and Out-of-The-Money options will expire worthless.
- The underlying contract is the December Future of the relevant year. For example, the underlying for the Mar 2021 option is the Dec 2021 Future.

Source: ICE website.

Derivatives play an essential role in carbon markets. They can transfer a wide range of risks in the economy from one entity to another, and in doing so help improve the efficiency of markets.

Derivatives markets also play a major role in enhancing transparency by contributing to market participants' assessment of future carbon pricing. In doing so, they contribute to long-term sustainability objectives and provide helpful signals to policymakers that are relevant to the regulation of carbon emissions.

Carbon derivatives also provide participants with the ability to hedge risks associated with fluctuating energy prices (see section 3.4 for some examples). They can be used by companies that are directly or indirectly exposed to carbon prices.

- For instance, compliance entities can use emissions derivatives to meet their obligations and manage their risks in a cost-efficient manner.
- Other companies (without compliance obligations under the EU ETS) that produce or are investing in emissions-reductions technologies may also seek to use carbon derivatives to mitigate or avoid exposure to carbon price risk. They can do this by placing positions in futures and options markets.

The ability to hedge lowers the funding costs for these companies by reducing the uncertainty of their cash flows.[47] As summarised in Table 3.1, several academic papers show that, by reducing the volatility of these cash flows, hedging can have a tangible impact on the cost of capital. This research indicates that the ability to hedge can reduce the cost of debt by around 19–54 basis points (bp) and the cost of equity by around 24–78bp.

[47] In a frictionless market, individual investors can hedge themselves. If the assumptions of a perfect capital market are violated (e.g. if investors do not have perfect information or access to the same hedging instruments), firm-level hedging can increase shareholder value.

Table 3.1 Studies estimating the impact of hedging on the costs of financing

Study	Finding
Bartram et al. (2011)[1]	The use of hedging can reduce betas by 15–31%, which can translate to a cost of equity reduction of 75bp*
Campello et al. (2010)[2]	A change in hedging intensity by one standard deviation reduces loan spreads, lowering the cost of debt by 54bp
Carter et al. (2006)[3]	Jet-fuel hedging increases airline firm value by around 12–16%
Chen and King (2014)[4]	The cost of debt of hedgers is lower than that of non-hedgers by 19.2bp for investment-grade rating and 45.2bp for speculative-grade rating
Gay et al. (2011)[5]	Derivatives users have a cost of equity financing that is between 24bp and 78bp lower than that of non-derivatives users

Note: * The cost of equity reduction estimate is based on a market risk premium of 5%.

Source: [1] Bartram, S.M., Brown, G.W. and Conrad, J. (2011), 'The effects of derivatives on firm risk and value', *The Journal of Financial and Quantitative Analysis,* **46**:4, pp. 967–99. [2] Campello, M., Lin, C., Ma, Y. and Zou, H. (2010), 'The real and financial implications of corporate hedging', NBER Working Paper No. 16622. [3] Carter, D.A., Rogers, D.A. and Simkins, B.J. (2006), 'Does hedging affect firm value? Evidence from the US airline industry', *Financial Management*, **35**:1, pp. 53–86. [4] Chen, J. and King, T.D. (2014), 'Corporate hedging and the cost of debt', *Journal of Corporate Finance*, **29**, pp. 221–45. [5] Gay, G.D., Lin, C.M. and Smith, S.D. (2011), 'Corporate derivatives use and the cost of equity', *Journal of Banking & Finance*, **35**:6, pp. 1491–506.

Sometimes the time period of the risk exposure that is required is later than the delivery dates of all the futures contracts that can be used. The hedger must then roll the hedge forward by closing out one futures contract and taking the same position in a futures contract with a later delivery date. Hedges can be rolled forward many times—a procedure known as 'stack and roll'.

EUA derivatives contracts also provide useful pricing signals for investors seeking to allocate capital to projects that would benefit from the energy transition and/or to assess and manage the climate transition risks in their portfolios.

Several derivatives exchanges offer standardised futures and options derivatives contracts on EU emissions allowances, as shown in Table 3.2.

Table 3.2 Exchange-traded contracts for EU emissions

Trading venue	Primary market	Secondary markets
New York Mercantile Exchange	n/a	In Delivery Month EUA futures In Delivery Month Options on EUA futures
EEX	Auctions of EUA and EUAA	Daily futures on EUA and EUAA Monthly, quarterly, and yearly futures on EUA Yearly options on EUA futures Yearly futures on EUAA
ICE	n/a	Daily futures on EUA Monthly futures on EUA Monthly futures on EUAA Quarterly options on EUA futures
Nasdaq Oslo	n/a	Daily futures on EUA Quarterly and yearly futures on EUA

Note: monthly contracts can be traded as part of a strategy which allows a market participant to effectively trade a quarter or full year.

Sources: ESMA (2021), op. cit., https://www.cmegroup.com/trading/energy/emissions/?redirect=/trading/energy/emissions/index.html (accessed 13 December 2021) and interviews with ICE.

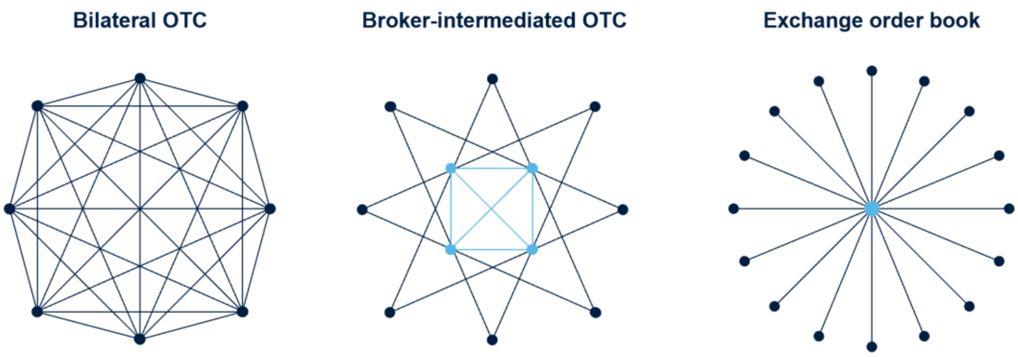
3.2 What is the role of derivatives exchanges?

Trading in EUA derivatives takes place on organised derivatives exchanges and over-the-counter (OTC).

OTC is a broad term, referring to trading amongst decentralised networks of buyers and sellers, usually intermediated by a small number of highly interconnected financial institutions (brokers). OTC trading can also take place on a bilateral basis, whereby the counterparties have direct relationships with each other.

In contrast, exchange trading takes place on a single centralised order book and on a multilateral basis (i.e. all buyers and sellers interact with each other at the same time). These different models are illustrated in Figure 3.1 below.

Figure 3.1 Different models of trading

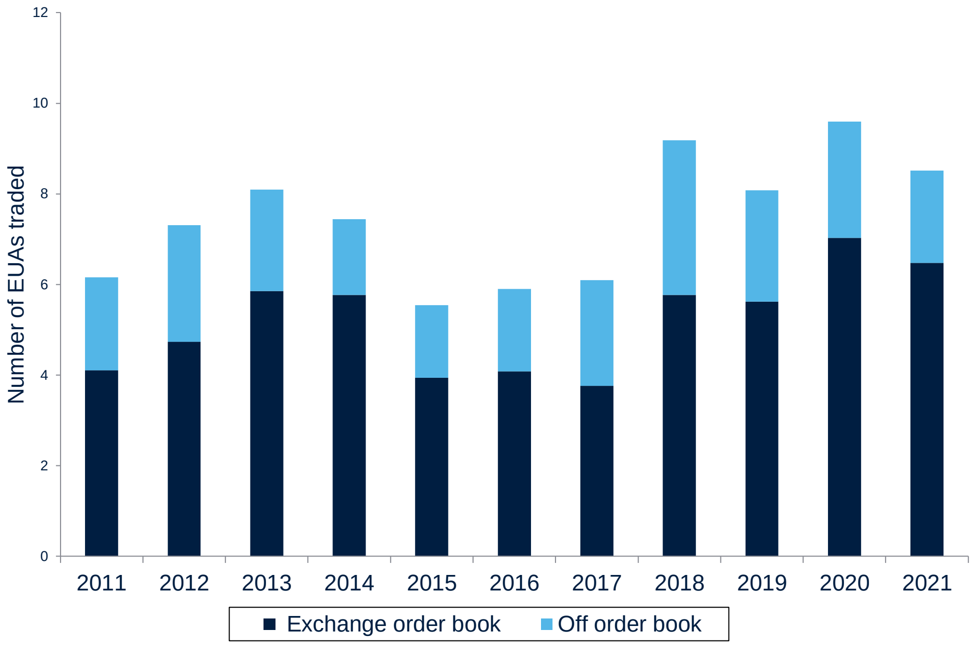


Source: Oxera.

As with many newer commodity markets, early trading activity in EUAs predominantly took place through direct bilateral contracting or via voice- and electronic-brokerage platforms. However, the share of exchange trading increased relatively quickly, such that by the end of phase 1 of the EU ETS in 2007, around one-third of trading volumes was executed on exchanges.[48] Currently, c. 70% of trading activity takes place on the order book of exchanges, as shown in Figure 3.2 below.

[48] See Ellerman, A.D. and Joskow, P.L. (2008), 'The European Union's Emissions Trading System in Perspective', May.

Figure 3.2 EUA futures trading volumes by trading mechanism, 2011–21 YTD



Note: The y-axis unit is billions of EUAs traded, where 1 EUA = an entitlement to emit 1 metric tonne of CO_2e. Data includes trading volume of EUA futures and excludes EUA options. Exchange order book trading consists of trading that takes place on the order books of ICE, EEX and Nasdaq. Off order book trades consists of pre-negotiated / brokered trades reported to the exchange as block trades. 2021 data covers January–October.

Source: Oxera analysis of trading data from Trayport Limited.

This transition of EUA trading towards a centralised, liquid and transparent exchange order book has relied, in part, on the investments undertaken by derivative exchanges to facilitate price formation and trading. This includes providing the physical platform infrastructure and setting the rules by which orders interact, as well as ongoing activities such as monitoring and surveillance (see Box 3.2 below).

The transition of EUAs to exchange-based trading has had important implications for the overall development of the EU carbon trading market.

- First, compared to OTC trading models, exchange trading can reduce barriers to entry for new participants and make trading more accessible. New trading participants do not have to establish bilateral trading, credit, and settlement relationships with incumbent participants. Instead, traders can access an exchange's platform through a single point of entry: the exchange. This access also means that a trader can execute against all counterparties posting prices on an exchange, in comparison to broker venues, in which the trader can trade only with counterparties with which it has established a trading and credit agreement. In the case of EUAs, exchange-traded futures may be easier to access for certain investors (e.g. UCITS funds) than the primary or OTC markets.
- Second, exchange trading rules facilitate non-discretionary, anonymous and multilateral trading. The non-discretionary nature of an exchange order book means that orders are matched automatically on a price–time basis. Therefore, in order to trade, participants must provide competitive quotes (i.e. lower ask prices or higher bid prices). Anonymity of trading can also

bring benefits to participants by reducing the risk of information revelation and adverse selection.[49]

- Third, by opening up opportunities to a broader, more diverse group of market participants, exchanges facilitate the provision of liquidity, to the benefit of carbon emitters with compliance obligations. These companies will often need to purchase futures to meet their regulatory obligations and manage risk in a cost-effective way.
- Fourth, exchange trading takes place in a highly transparent environment, where quotes (pre-trade information) and prices (post-trade information) are visible to all traders. Markets with a centralised price-formation mechanism (combined with market surveillance and enforcement) tend to be less susceptible to price manipulation than markets that are characterised by opaqueness and price dispersion (i.e. identical assets trading at different prices at the same time).

[49] Knowing the identity of the participant may provide information with respect to the direction (buying or selling) of the trade, and the pricing available may therefore be framed differently.

Box 3.2 Activities undertaken by derivatives exchanges to facilitate EU carbon trading

To facilitate a reliable and efficient price-formation process in the trading of EUA futures and options, a derivatives exchange undertakes several activities, some of which provide direct benefits, while others are more indirectly beneficial, but still important.

The range of activities can be divided into the following groups.

1. Providing highly resilient platform infrastructure

To facilitate trades, the first requirement is that market participants have access to a forum where they can meet and indicate their intentions. Derivative exchanges, such as ICE, provide this through online electronic platforms that allow users to specify their price and volume conditions anonymously and be matched with others who are willing to trade on those terms.

ICE, for example, grants free, non-discriminatory access to its WebICE platform to market participants who meet authorisation requirements. By vetting potential members, and requiring members to have systems in place to vet their clients in turn, derivatives exchanges ensure that their members hold the licences, permits, necessary expertise and other requirements to conduct business on the relevant exchange.

2. Attracting a good mix of participants

Derivative exchanges aim to achieve trading flows from buyers and sellers , and therefore seek to attract the right sorts of users to the platform and facilitate a healthy mix of participants. As noted above, one way of maintaining quality control is by making sure that potential members meet authorisation requirements.

In the exchange model, all participants enter the market via a single point of access and trading takes places on a multilateral basis (i.e. all buyers and sellers interact with each other at the same time). As well as reducing search frictions associated with trading on a bilateral basis, centralised trading platforms can also reduce the cost of trading through increased competition and liquidity provision.

3. Setting the rules of the game

Another activity undertaken by derivatives exchanges is the setting of rules that dictate the price-formation process. Exchanges have a responsibility to publish and provide rules on many aspects of the trading process, including, for example, establishing order quantity limits, price reasonability limits, interval price limits and settlement periods. Further information on price reasonability and interval price limits is provided in Box 3.3.

By creating a rule book to establish acceptable trade practices, exchanges can minimise fraudulent activity and protect property rights, as well as reducing the transaction costs associated with trading.

4. Monitoring and enforcement

In addition to setting the rules that traders must follow on their platform, derivates exchanges must monitor and enforce their rules, including reporting potential breaches of the EU's Market Abuse Regulation (MAR). The process of monitoring and enforcement is self-regulated, but is also often conducted in collaboration with the relevant regulatory authorities.

Surveillance and detection tools alert exchanges of unusual behaviour. Exchanges establish conditions which, when met, trigger alerts. Upon notification of a surveillance alert, the exchange can conduct an investigation, and this could result in a Suspicious Transaction Report (STOR) sent to the relevant National Competent Authority. Alert conditions can be set to detect price or volume spikes or alert the exchange to more specific suspicious user behaviour.

Another example of monitoring and enforcement activities conducted by exchanges is the use of interval pricing limits. These price limits act as temporary circuit breakers that reduce the likelihood of short-term price spikes or outsized market movements. Interval pricing limit parameters can vary over time based on market conditions, but are intended to be triggered only in the case of extreme price moves over short periods of time. See Box 3.3 for more information about interval pricing limits.

Source: Oxera, based on interviews with ICE and carbon traders.

3.3 Regulatory framework governing carbon trading

The trading of EUA contracts and EUA derivatives is a well-regulated activity in the EU. In particular, the EU regulatory framework around EUAs and EUA derivatives is made up of the following:[50]

- the Markets in Financial Instruments Directive and Regulation (MiFID II and MiFIR);
- the MAR and the European Market Infrastructure Regulation (EMIR);
- the tools available to ESMA and the national competent authorities (NCAs) to monitor and supervise this market.

As such, the trading of EUAs and EUA derivatives is subject to certain rules aimed at promoting market transparency and integrity, as well as preventing market abuse and market manipulation. For example, the EU legislative framework sets out who can buy and sell EUAs and EUA derivatives and under what conditions. In particular, the EU Market Abuse Regulation (MAR) prohibits insider dealing, unlawful disclosures of insider information and market manipulation.[51] Companies with large installations regulated by the EU ETS are subject to stricter rules on inside information to prevent unfair advantage among market participants. There are also separate rules governing the activities of participants in the primary auctions and the secondary markets.

Derivatives on the most liquid emissions allowances contracts are subject to weekly and daily position reporting. These reporting requirements apply to contracts with at least 20 market participants and an absolute amount of the gross long or short volume of total open interest of at least 10,000 lots for commodity derivatives. Included in this reporting framework are EUA futures traded on ICE and EEX. Position reports are not made available on derivatives traded in OTC markets, on EUAAs, daily futures on EUAs, options on EUA futures, or EUA futures traded on Nasdaq Oslo.

Emissions allowances are not subject to position limits and position management controls based on rules under MiFID II. However, derivatives exchanges, such as ICE, conduct position management and market surveillance activities on these assets. Box 3.3 below summarises some of the main market surveillance activities that ICE conducts to ensure an orderly functioning of its carbon derivative markets. These activities are supervised by the relevant NCA, such as the Dutch Authority for the Financial Markets (AFM) for ICE Endex.

[50] See Appendix A1 for a more detailed overview.
[51] 'Insider dealing' refers to the use of inside information to execute deals to one's advantage. This includes the execution of orders based on insider information, as well as the cancellation and amendment of orders based on insider information. 'Market manipulation' refers to the act of misleading the market through certain activity or to activities that manipulate the price. For more detail, see Regulation (EU) No 596/2014 of the European Parliament and of the Council on market abuse (market abuse regulation), https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0596&from=EN (accessed 31 January 2022).

Box 3.3 ICE's market surveillance activities in its carbon derivatives contracts

Systems and controls are important in reducing the likelihood of orders entered in error, preventing the execution of trades at unrepresentative prices, and reducing the market impact of such trades. ICE has implemented proactive and reactive measures to ensure that its carbon derivatives trading markets are well functioning and limit the likelihood of erroneous trades.

Examples of proactive activities (i.e. ex ante interventions) include the following.

- **No Cancellation Ranges (NCRs)**: except in exceptional circumstances, once executed a trade will stand and will not be subject to adjustment or cancellation. NCRs therefore sets parameters above or below an exchange set anchor price for each contract within which a disputed trade will stand, even if executed in error.
- **Price Reasonability Limits**: these are price 'reasonability' limits to prevent 'fat finger' errors. The limit is the amount, set by the exchange, that the price may change in one trading sequence from the anchor price.
- **Interval Price Limits (IPL)**: these provide functionality to limit large price movements from occurring within a given timeframe. For each enabled contract, the exchange sets the IPL that limits the extent that prices can move within a set timeframe known as the 're-calculation time'. If a bid or offer attempts to breach the IPL, the market will enter a hold period preventing any further trading beyond the limit until the end of the hold period.
- **Position management controls**: exchanges monitor open interest developments on an ongoing basis and sets accountability levels in the spot month and other months when it deems it is necessary to prevent and address disorderly trading, support orderly pricing and settlement conditions, and ensure the efficiency of markets. Position management considers positions held by position holders, and any risks these may present to market order, in the context mainly of: pricing and price trends in the relevant markets; the nature of the position holder; the positions in related markets; concentration; position development over time; seasonality; open interest; activity in related underlying financial instruments; incentive scheme participation; and the extent and quality of engagement with the exchange and response to inquiries.
- **Other measures**: exchanges can set volume reasonability limits that prevent volumes going above a certain level to be either designated for trading or traded. For example, ICE offers optional pre-confirmation messages which appear to market participants before the execution of all trades. The platform also provides the option to limit the quantity that a user can trade rather than trading the total quantity that is available to be traded at a specific price.

Examples of reactive activities (i.e. measures applied ex post) include the following.

- **Trade Adjustment Policy**: any trade executed at a price within the price reasonability limit but outside of the NCR for that contract, if notified to an exchange within the designated time period of eight minutes from the time of the original trade, will be investigated by market supervision.
- **Trading alerts**: ICE monitors EUA futures and options contracts to detect market anomalies and market abuse. A dedicated market surveillance team supervises the alerts triggered, replies to users' queries, reports potential regulatory breaches, and conducts investigations in collaboration with the relevant competent authority where needed.

Exchanges undertakes these activities in close collaboration with the relevant competent authorities. There are also regular meetings between exchanges and the relevant authorities to follow up on market monitoring activities.

Source: Oxera analysis based on ICE internal and public information. See ICE Endex 'Policy – Price Adjustment and Trade Cancellation', https://www.theice.com/publicdocs/endex/ICE_Endex_Trade_Cancellations_Price_Adjustment.pdf, accessed 25 January 2021; ICE Endex 'No Cancellation Ranges, Reasonability Limits and Interval Price Limits', https://www.theice.com/publicdocs/endex/ICE_Endex_NCR_Reasonability_Limits.xlsx (accessed 25 January 2021). ICE Endex 'Position Management Controls Policy'.

There have been some calls for the EU to impose position limits on emissions allowances. The economics literature is generally sceptical about the efficiency benefits of regulators imposing such position limits on market participants in futures markets, despite the good intentions of ensuring efficiency and price formation. Appendix A2 summarises the literature on position limits.

3.4 Trading strategies—who trades and why?

The market microstructure literature refers to three broad categories of traders in derivatives markets and this is no different in the case of the trading of EUA futures and options.[52] At a high level, there are:

- **hedgers**—which use derivatives to reduce the risk they face from potential future movements in a market variable. The variable in this case is likely to be the price of an EUA, but it could also be the price of a related variable, such as another carbon price, a related energy price, or another variable highly correlated with EUAs;
- **speculators**—which use the instruments to take a position on the future direction of a market variable;
- **arbitrageurs**—which take offsetting positions in two or more financial instruments to lock in a profit.

In practice, some institutions may undertake a mixture of these activities. For example, a trading entity may engage in a combination of arbitrage, speculative and/or hedging strategies, depending on their specific strategy and risk appetite.

It is important to draw a distinction between speculation and market manipulation. Market manipulation is illegal and impairs market functioning. Speculation is an important part of ensuring the well-functioning of a trading market.

In a market such as the trading of emissions allowances, many participants are naturally seeking to hedge by taking net long future positions. In such a market, meeting hedging demand requires counterparties that are willing to take complementary short futures positions. Such a hedging counterparty role is typically assumed by financial intermediaries, and this is what we see in practice in the case of the trading of EUA futures.

Table 3.3 below describes the typical trading strategies applied in EUA futures categorised by type of institution.

[52] Hull, J.C. (2022), *Options, Futures and Other Derivatives*, 11th Ed., Pearson, chapter 1, pp. 23–45.

Table 3.3 Typical trading strategies in EUA futures

Category of institution	Examples	Motivation(s) to trade	Typical trading strategy
Emitters	Commercial entities in power and heat generation, energy-intensive industry sectors including oil refineries, steelworks, production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals	Meeting compliance obligations Hedging against EUA price and volumes risks	Buy EUA futures to meet compliance obligations and/or hedge Sell EUA futures if have 'excess' EUAs
		Taking positions	Mix of long and short positions
		Freeing up short-term capital	Sell EUAs and buy EUA futures
Low-carbon innovators/ entrepreneurs	Firms investing in emissions-reduction technologies	Hedging against EUA price and volume risks	Buy EUAs and sell EUA futures
Investment firms or credit institutions	Banks	Market-making (to profit from the difference in the bid–ask spread) Market access for compliance entities	Mix of long and short positions
		Carry trade	Buy EUAs and sell EUA futures
Investment funds	ETFs, pensions funds, insurance companies, collective investment schemes	Exposure to carbon as an asset class Hedging against inflation risks Seeking potential diversification due to historically low correlation to traditional asset classes	Predominantly buy EUA futures
Other trading houses	Algorithmic trading firms, commodity traders	Market-making (to profit from the difference in the bid–ask spread) Seeking arbitrage opportunities Taking positions	Mix of long and short positions

Note: "Emitters" refers to firms with obligations under the EU ETS plus associated commercial undertakings, as defined in ESMA (2021), 'Questions and Answers on MiFID II and MiFIR commodity derivatives topics', pp. 39–40, https://www.esma.europa.eu/sites/default/files/library/esma70-872942901-36_qas_commodity_derivatives.pdf (accessed 30 December 2021). Carry trade refers to a trading strategy of being long on the physical certificate and short on the future, providing clearing house disintermediated financing for commercial undertakings. CCS refers to technologies that capture and store emitted CO_2 to prevent it from entering the atmosphere.

Source: Oxera.

Energy producers and industrial groups often seek to buy EUAs via the futures market to hedge their exposure to the carbon price and to ensure that they have enough credits to cover anticipated emissions. They may also short EUA futures if they have emitted less than planned in the previous year. Box 3.4 and

Box 3.5 below set out case studies to demonstrate the benefits to compliance entities of trading EUA and EUA derivatives. Box 3.6 details how emitters and investors might profit from carry trades and cash flow management using carbon derivatives.

Emitters in other sectors (e.g. shipping, buildings and transport), which are not currently within scope of the EU ETS, may also seek to offset or hedge their carbon footprint via the trading of EUA futures, for ethical reasons and/or in anticipation of the scope of the EU ETS expanding in the future under the Fit for 55 package.

Financial intermediaries typically seek to trade EUAs and EUA futures and options with a view to providing liquidity for their clients (and then profiting from the difference in the bid–ask spread) and/or market access (some entities may ask a financial institution to trade on its behalf on an agency basis if they find it too complex or expensive to buy EUAs or EUA futures directly via the auction or the orderbook of an exchange).

Investment funds may buy EUA futures to gain targeted exposure to the EUA cap-and-trade allowance programme. In recent years there has been growth in the number of funds holding positions in EUA futures; however, the size of these positions remains limited to date (representing only 4.1% of total positions in EUA futures in the week commencing 8 November 2021 and 4.6% on average throughout 2021 up until November 2021).[53] Investors also combine portfolios investing in EUAs with other carbon funds to attune their allocation to the global carbon credit market. There may also be other motivations. For example, funds may invest in EUAs owing to the potential for portfolio diversification due to the historically low correlation with traditional asset classes or to hedge against inflation risks, among other reasons.[54] Examples of funds buying EUAs include KraneShares European Carbon Allowance ETF, iPath EU Carbon exchange-traded note and WisdomTree's European fund. Other prominent investment funds taking positions on EUAs include SparkChange's exchange-listed ETC (which seeks to invest in EUAs in the primary market) and Carbon Cap Management's World Carbon hedge fund.

As is evident from analysis of the commitment of traders (COT) reports of ICE and EEX for EUA futures, the largest trading positions are between financial institutions selling EUA futures against commercials entities that buy them with a view to hedging EUA price and volume risk to meet their compliance obligations under the EU ETS, as discussed in section 3.3.

[53] Source: Oxera analysis of ICE's commitment of trader (COT) reports.
[54] See, for example, the correlation matrix in ICE (2021), 'ICE Carbon Futures Index Family', p. 3. https://www.theice.com/publicdocs/ICE_Carbon_Futures_Index_Family_Primer.pdf (accessed 30 December 2021).

Box 3.4 An illustrative example of the gains of trading EUAs to compliance entities

A simple numerical example illustrates how the ability to trade emissions permits can reduce the costs to compliance entities.

Take two facilities that earn the same marginal profit per unit before accounting for the cost of carbon emissions. These may be two facilities owned by different companies in the same sector or plants in completely different sectors.

- Facility 1 incurs a cost of €50/tCO_2e emissions reduction.
- Facility 2 incurs a cost of €300/tCO_2e emissions reduction.

Clearly the emissions reduction can be achieved at lower compliance costs at Facility 1 than at Facility 2.

Suppose the price of an EUA is €200/tCO_2e and that the two facilities were initially allocated EUAs consistent with the individual emissions levels required under the emissions standard.

Facility 1 (the low-cost seller) gains by reducing its emissions further than the standard requires and selling the allowance it no longer needs to Facility 2.

- Facility 1 receives €200 for the emissions allowance but pays only €50 to achieve the emissions reduction, for a net gain of €150.
- Facility 2 is able to buy the emissions allowance for €200 and reduce its compliance costs by €300, for a net gain of €100.

Thus the total gain from trading is split between the buyer and the seller, with both gaining from trading the EUA.

Source: Oxera, based on Ellerman, A. and Harrison, D. (2003), 'Emissions trading in the U.S.', Pew Center on Global Climate Change, https://web.mit.edu/globalchange/www/PewCtr_MIT_Rpt_Ellerman.pdf (accessed 30 December 2021).

Box 3.5 Case study: power utility hedging using EUA futures

Consider a large power utility, which endeavours to meet the energy needs of its customers. This utility has many plants, with different energy types, and will use whichever plants it expects will be most efficient to meet demand.

The utility anticipates needing to generate 10GWh of electricity in the near future to meet expected demand. It intends to generate 5GWh of this from gas plants, knowing that EUAs are required to cover the resulting emissions. The utility then works out how many EUAs are required to meet that 5GWh gas volume.

Once the utility has estimated how many EUAs it will need in the following year to cover its production, it has a choice: to wait until the permits are needed and buy the EUAs in the primary auction at that time, or to secure the required number of permits now on the futures market for its production in the following year.

Even if the utility has no knowledge about whether future EUA prices are going to increase or decrease, it might still choose to purchase the EUAs at the known futures cost in order to 'lock in' a price, thereby minimising risk exposure and helping it to get greater certainty over its future margins.

Source: Oxera, based on interviews with carbon traders.

Box 3.6 Case study: carry trades and cash flow management

Investors and emitters can engage in strategies that make the most of differences between the price of EUAs and EUA futures. A 'long carry' involves the purchase of an EUA and selling an EUA futures contract. It is also possible to do the opposite. A 'short carry' involves selling an EUA and buying an EUA futures contract.

While a long carry might be the preferred strategy for investors looking to achieve trading profits, the short carry may benefit utilities or other emitters as it frees up cash in the short term while also leaving them holding EUAs that are required to cover their emissions at some future date.

Long carry

Consider a trader who undertakes a long carry. As noted above, this means that it buys an EUA and sells a later-dated futures contract. This strategy will generate revenue for the trader in cases where the price of the EUA future is higher than the current EUA price, while also hedging against interim price movements.

To demonstrate this, imagine that the price of an EUA is €20, while the one-year futures price is €21 to receive an EUA in a year's time. To complete the trade, the trader purchases 100 EUAs at today's price for €2,000 (€20 x 100) while also taking a short position (i.e. selling) 100 EUAs at the futures price for €2,100 (€21 x 100). In addition, the trader is required to post a certain amount of collateral to meet margin requirements on its short futures position.

A year later, the futures expire and the trader is paid €2,100 for selling the 100 EUAs that it bought at the spot price a year previously, and any collateral posted is returned. From the trader's perspective, the gross profit from the long carry would be €100 (€2,100 – €2,000) less the exchange, clearing and registry fees, and after paying the interest on any funds borrowed to finance the purchase of EUAs at the outset.

Short carry

Emitters can take the opposite position by selling an EUA at the spot price and buying an EUA future. A short carry would allow an emitter with EU ETS compliance obligations to free up cash in the short term while still ensuring that it secures access to EUAs in time to submit these to the relevant authorities.

To demonstrate this, consider an emitter that is currently holding 100 EUAs that it knows it will need to submit in one year's time to cover its emissions arising from gas-fired electricity production. Assume that the EUA and futures prices are the same as in the long carry example. To complete the trade, the emitter sells its 100 EUAs for €2,000 (€20 x 100) while also purchasing 100 EUA futures expiring in one year's time at a cost of €2,100 (€21 x 100).

In the year between undertaking the trade and the futures expiring, the emitter benefits from access to €2,000 in cash and it receives 100 EUAs when its futures expire. In this instance, the cost of freeing up €2,000 was €100 plus any exchange and clearing fees and margin requirements. This may be an important cash flow management strategy for emitters that want to borrow but might otherwise have to pay high interest rates using traditional routes—for example, for entities with a low credit rating.

Source: Oxera based on interviews with carbon traders.

As highlighted in Table 3.3 and in Box 3.6, carry trades provide benefits to emitters and commercial undertakings as well as remunerating financial firms for costs and risks of taking the other side of these trades. It therefore follows that if position limits were imposed in a way that was binding on financial firms, then this could result in commercial firms (including emitters with compliance obligations) not being able to purchase futures. Alternatively, position limits could result in higher trading costs and counterparty risks if commercial firms instead sought to meet their hedging requirement through OTC transactions. In turn, the higher costs of exchange trading becoming less liquid would also impact all market participants.

4 Evidence of market functioning

4.1 Our approach and economic framework

A well-functioning financial market is one that delivers a high-quality, trusted price-formation process, and provides liquidity during normal market functioning and in times of stress, while remaining resilient to manipulation and abusive practices.

Markets that satisfy these core functions bring important benefits to end-users—for example, by providing trusted, reliable pricing signals, as well as allowing companies and investors to (re)allocate their holdings of EUAs at low cost, enabling them to manage their financial risks according to their preferences.

When assessing whether a market is performing these functions well, there are a number of metrics that are useful to consider, as shown in Figure 4.1. These metrics are analysed in this section, to assess the economic performance of the market for trading EUA futures.

Figure 4.1 Economic framework for assessing the functioning of financial markets

Source: Oxera.

Our approach was to conduct empirical analysis based on data from ICE, EEX, and publicly available sources. We also reviewed the academic and policy literature, which supported our findings.

Our key findings are as follows.

- Over time, the trading of EUA futures has developed from an OTC market to a predominantly exchange-traded one. This shift has had a positive impact on end-users—as the exchanges have been successful in attracting a more diverse group of market participants, exchange-trading has led to improvements in market resilience, price formation and liquidity.
- There is a wider and more diverse set of traders active in the market, including a wide range of financial and non-financial participants. Data from the COT reports suggests that financial firms play a different role in the market to non-financial firms.
- The relative cost of trading has reduced since 2017 as the amount of trading on-exchange and the number of market participants have continued to

increase. This compares to previously observed trends of falling absolute and relative costs during earlier phases of the EU-ETS.

- Price formation has improved over time as more contracts became available for trading, despite challenges associated with policy uncertainties. Trading quality and market efficiency has improved markedly, particularly since the early phases of the EU ETS.
- Overall, the evidence available to date indicates that the market for the trading of EUA futures is functioning well and is now seen as a successful case study for other regions seeking to develop (or integrate) their own carbon trading markets.

These points are examined in turn below.

4.2 Evidence on resilience

'Resilience' in this context refers to the ability of the market to absorb, rather than amplify, shocks and remain free from manipulation and abusive practices. As noted by IOSCO, this is particularly important in commodities derivatives markets, where the supply of the underlying asset is limited.[55] Limits on the supply of a commodity to be delivered can result in market congestion, squeezes, cornering or other disruptions,[56] all of which can lead to a poorly functioning derivatives market.

In the market for EUAs, there are several reasons why it is relatively difficult for an individual participant to exercise market power or otherwise distort the EUA price.

First, EUAs are bankable from previous EU ETS phases (see section 2.1.3) and compliance periods (calendar years), which means that the quantity of EUAs in circulation that can be used to fulfil derivatives contracts or to meet compliance obligations is currently much larger than the total volume of EUA derivatives contracts.

Figure 4.2 below shows the TNAC and open interest in EUA futures traded on ICE between 2018 and 2020. As can be seen, the total quantity of allowances in circulation was a multiple of the amount of open interest in EUA futures. This ratio is expected to decrease as a result of the MSR (see section 2.1.3), but, due to the lower threshold in the MSR for release of allowances, TNAC is expected to continue to exceed the amount of open interest in EUA futures for the foreseeable future.[57]

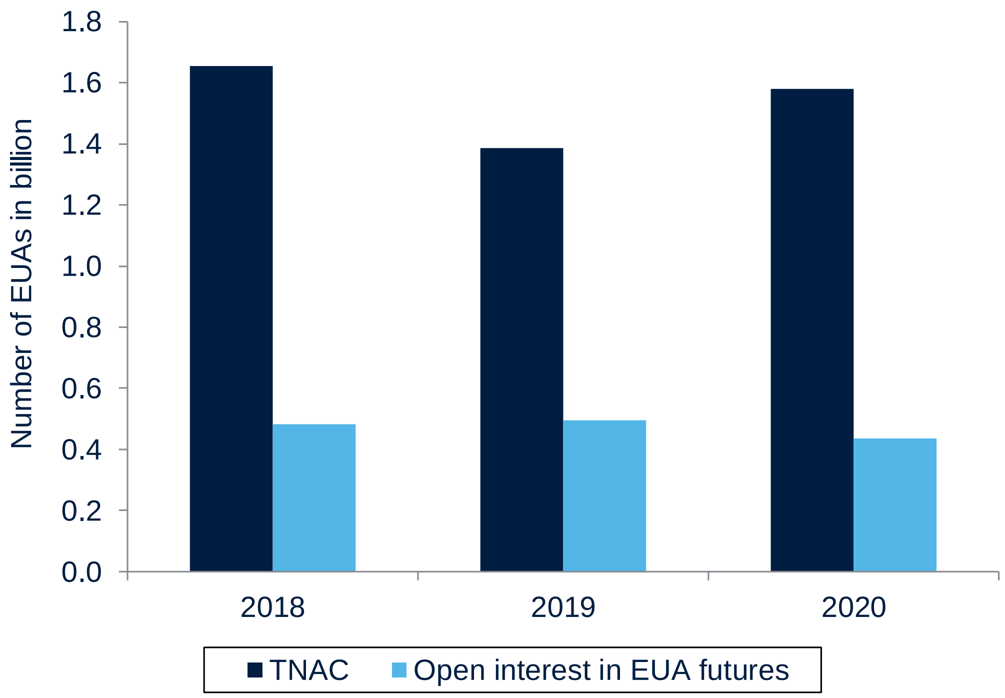
Second, the actual surrender of EUAs for compliance purposes occurs only once per year (30 April) and after the end of the compliance year (31 December). This is in contrast, for instance, to the power market, where the underlying commodity needs to be made available every hour at a substantial cost for non-delivery. To squeeze the power market, a market participant potentially needs to be pivotal in a given hour only, while to corner the EUA market a participant to hold a substantial proportion of the TNAC.

[55] IOSCO (2021) 'Principles for the Regulation and Supervision of Commodity Derivatives Markets', November 2021.
[56] A market 'corner' or 'squeeze' describes a situation where the underlying asset or commodity necessary for delivery on expiration of a futures contract is held by one or more market participants acting in concert constitutes a substantial proportion of the quantity of underlying commodities eligible for delivery against the contract. IOSCO (2021), op. cit.
[57] The calibration of the MSR includes within Directive 2018/410/EU a threshold for the release of incremental allowances into the market where the TNAC is below 400m EUAs.

Furthermore, a substantial share of EUAs was freely allocated to compliance entities, which could sell their EUAs to the market if a price squeeze occurred.

Third, the trading of EUAs is purely electronic and involves only negligible storage, transport and carry costs. In contrast to physical commodities such as gas and oil, cornering the market for EUAs is more difficult because any market participant can supply allowances to any other participant—irrespective of their location—immediately and without any transport costs.

Figure 4.2 Total number of allowances in circulation and open interest in EUA futures, 2018–20



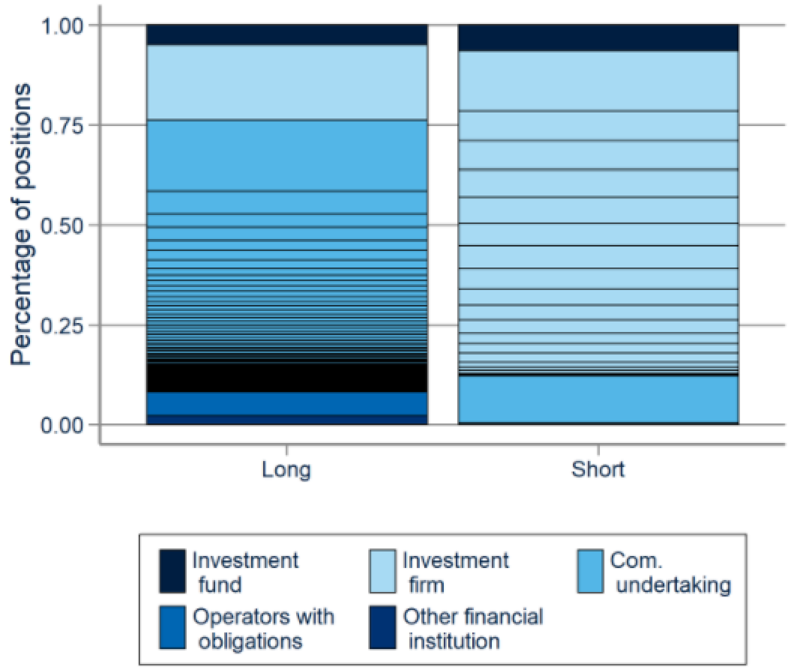
Note: The y-axis unit is the number of EUAs in billions. Open interest in EUA futures is calculated as the yearly maximum open interest for contracts with expiry date in a given year. For example, the open interest in 2020 corresponds to the largest open interest throughout 2020 for contracts with delivery in 2020.

Source: Oxera analysis of ICE data and European Commission data on TNAC.

One indicator of market functioning is the number of complaints. Complaints could signal lack of resilience to market manipulation or abusive practices. Oxera understands that ICE Endex has received no complaints from market participants trading EUA derivatives on its platform.

Another way to assess the current resilience of the EUA futures market is to examine the market shares held by the largest market participants. The larger the market shares the more likely it is that one of the participants could exert a degree of control over quantities and prices. Figure 4.3 shows a snapshot of EUA derivatives contract positions held by individual traders in October 2021 on ICE. As can be seen, the largest individual market participant (an investment firm) held only around 15–20% of the open interest. This corresponds to roughly 5% of all EUAs in circulation, which is unlikely to be sufficient to exert a significant degree of control. In the case of investment firms, this share is likely to be held on behalf of multiple beneficial owners.

Figure 4.3 Shares of long and short positions by trader category in October 2021



Note: The trader categorisation follows the definitions used in the COT reports. For the largest trader category of both long (i.e. commercial undertakings) and short positions (i.e. investment firms) the chart presents the positions broken down at the trader level.

Source: Oxera analysis based on ICE data.

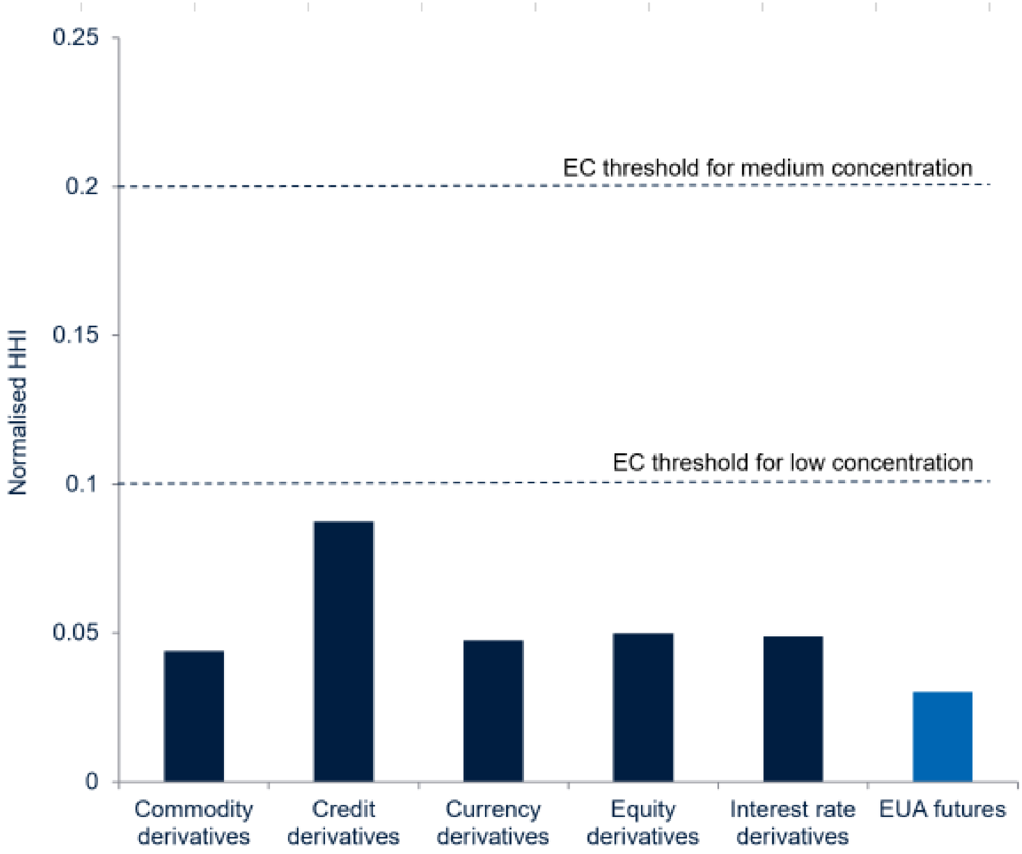
The normalised Herfindahl–Hirschman Index (HHI) of net positions in EUA futures was 0.0421 in October 2018 and 0.0303 in October 2021.[58] As noted by ESMA, an HHI value of below 0.1 indicates low concentration and an HHI between 0.1 and 0.2 indicates medium concentration.[59] A less concentrated market structure decreases the probability of market manipulation and means that if one trader exits, the impact on the market will be small.

It is useful to compare the level of concentration in EUA futures with other types of derivatives. ESMA calculated the HHI of derivative exposures in 2020 and found low concentrations across all asset classes, ranging from 0.04 for interest rate derivatives to 0.08 for credit derivatives. As shown in Figure 4.4, the market concentration of EUA futures is even lower than all of these categories.

The level and reducing trend of HHI in EUA futures, as well as the limited market share of the largest EUA futures long and short position holders, indicate a high level of competition and market resilience in the trading of EUA futures.

[58] Oxera analysis of ICE's positions data. The Herfindahl–Hirschman Index (HHI) is a common measure of market concentration and is used to determine market competitiveness, often pre-/post-merger and acquisition (M&A) transactions. HHI is calculated as the sum of market shares squared of all participants in the market, and ranges between 0 (perfect competition) and 10,000 (monopoly). The European Commission's merger guidelines state that the Commission is unlikely to identify competition concerns in a market with a post-merger HHI below 1000 (equal to a normalised HHI of 0.1).
[59] See ESMA (2021) 'EU Derivatives Markets: ESMA Annual Statistical Report 2021', 17 December 2021, ESMA-50-165-2001, https://www.esma.europa.eu/sites/default/files/library/esma50-165-2001_emir_asr_derivatives_2021.pdf (accessed 31 January 2021), footnote 22.

Figure 4.4 Concentration of trading activity: EUA futures vs other derivatives



Note: HHI normalised between 0 and 1. HHI value for EUA futures taken from analysing ICE position data at trader level for October 2021. HHI value for other categories of derivatives taken from ESMA analysis of derivatives exposures for Q4 2020 in its 2021 Annual Statistical Report on the EU derivatives market. ESMA noted that the HHI metrics in Q4 2020 were similar to those of a year earlier across all assets. According to ESMA and the European Commission's guidelines (in the context of competition law) an HHI value of below 0.1 indicates low concentration and an HHI value of between 0.1 and 0.2 indicates medium concentration.

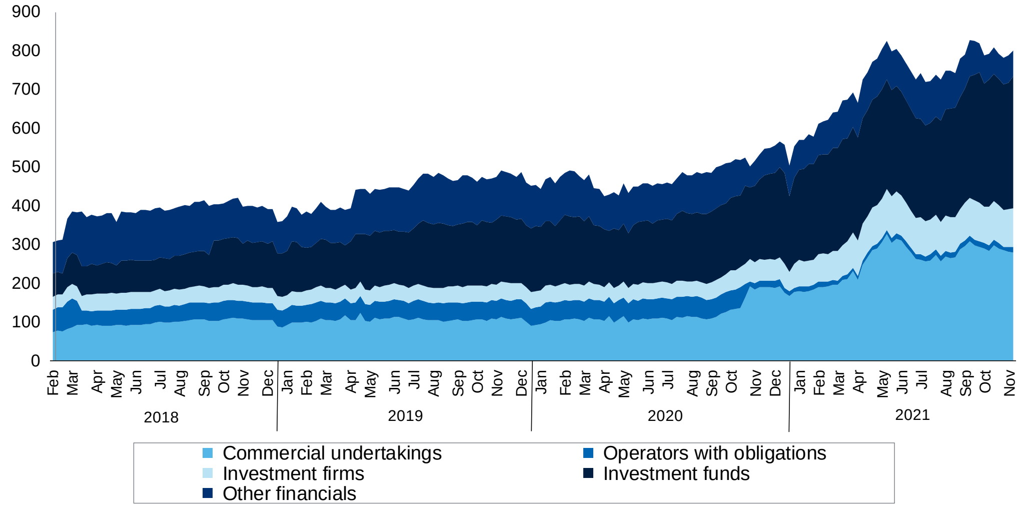
Sources: Oxera analysis of positions data received from ICE and ESMA (2021) 'EU Derivatives Markets: ESMA Annual Statistical Report 2021', 17 December 2021, ESMA-50-165-2001, https://www.esma.europa.eu/sites/default/files/library/esma50-165-2001_emir_asr_derivatives_2021.pdf (accessed 31 January 2021). European Commission, 'Guidelines on the assessment of horizontal mergers under the Council Regulation on the control of concentrations between undertakings', 2004/C 31/03, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52004XC0205%2802%29 (accessed 26 January 2021).

When assessing the resilience of a market, we can also consider the depth and breadth of participants active in the market. Examining the relative balance between non-financial participants, which are primarily using the market to hedge underlying exposures, and other financial participants, can also be helpful.

The depth and diversity of trading participants, as well as being a key driver of liquidity (see section 5.4), are also informative as to whether the market is at risk of price manipulation. A trading participant may have an incentive to manipulate prices in a number of ways—for example, a polluter seeking to reduce prices in order to reduce their financial burden, or a trader accumulating a sufficiently large long position to drive the price upwards. However, these concerns will tend to diminish in large markets, where exercising market power is much harder.[60]

Figure 4.5 below shows how the number of position holders in EUA futures has increased for most categories of participant. Overall, the number of financial participants holding positions (i.e. investment firms, investment funds and other financial firms) has increased from around 200 in early 2018 to over 500 in November 2021. Similarly, the number of non-financial participants (commercial undertakings and operators with obligations) increased from around 150 to almost 300 over the same period. There also appears to have been a re-categorisation whereby some firms previously classed as operators with obligations are now classed as commercial undertakings. This data is broadly consistent with recent analysis conducted by ESMA (across both ICE and EEX).[61]

Figure 4.5 Number of position holders of EUA derivative contracts traded on ICE, 2018–21



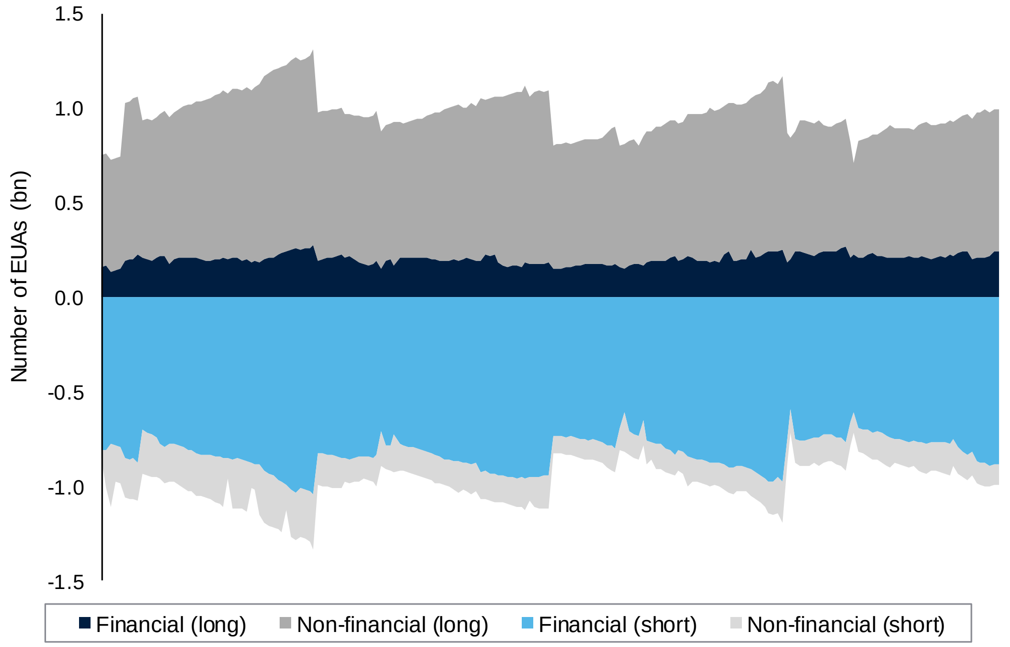
Note: The y-axis unit is the number of legal entities with positions in EUA futures. Changes in position allocations between groups might be due to misreporting, and might not reflect actual changes in the composition of position holders.

Source: Oxera analysis based on COT data from ICE.

Figure 4.6 provides a breakdown of the overall magnitude of the long and short positions held by participant type. This data shows that non-financial firms tend to hold long positions (dark grey), while financial firms tend to hold short positions (light blue). This is broadly in line with the expected functioning of the market, whereby non-financial entities buy EUA futures to hedge their carbon price exposure, while financial counterparties act as intermediaries to facilitate trading and provide liquidity to the market. Although the magnitude of positions held by all firm types follows an annual cycle, the overall magnitude of positions has remained broadly stable over the period.

[60] Tietenberg, T. (2011), 'Carbon pricing: lessons derived from experience', November, http://personal.colby.edu/personal/t/thtieten/TT_IMFdraft11-11%20full.pdf (accessed 30 December 2021).
[61] ESMA's analysis is based on weekly position reporting data it receives directly from trading venues. Analysis by ESMA found that the number of market participants has increased across all categories of participants, on both venues, and in relatively homogeneous proportions. See ESMA (2021), 'Preliminary report: Emission Allowances and derivatives thereof', November.

Figure 4.6 Commitment of traders for financial and non-financial firms, 2018–21

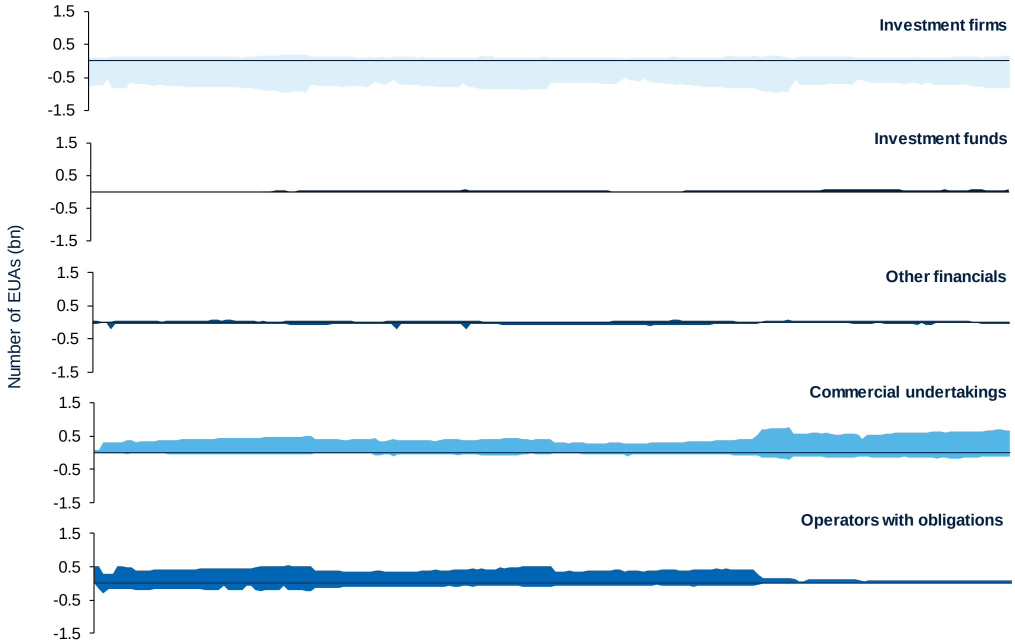


Note: The y-axis unit is billions of EUAs. Financial firms consist of investment firms, investment funds and other financial firms. Non-financial firms consist of commercial undertakings and operators with obligations.

Source: Oxera analysis based on COT data from ICE.

Figure 4.7 highlights that, within the broader category of financial firms, investment firms and investment funds account for the majority of positions and largely hold negative positions. In terms of magnitude, investment funds and other financials play a less prominent role.

Figure 4.7 Commitment of traders by participant type



Note: The y-axis unit is billions of EUAs. Size of long (above the axis) and short (below the axis) positions in EUA futures. This is the same data as shown in Figure 4.6. Changes in position allocations between commercial undertakings and operators with obligations might be due to changes in the reporting methodology and/or misreporting, and might not reflect actual changes in the composition of position holders. Until November 2020, ICE set this categorisation centrally based on researching if the position holder had an activity that would require them to register an installation. As part of ICE's approach, trading affiliates of large emitters were considered as operators with obligations. Since November 2021, position holders have self-reported their categorisation. We understand that many trading affiliates of large emitters were reported as commercial undertakings.

Source: Oxera analysis of COT data from ICE.

4.3 Evidence on price formation

Another important indicator often associated with well-functioning markets is the breadth of contracts available along the futures pricing curve.

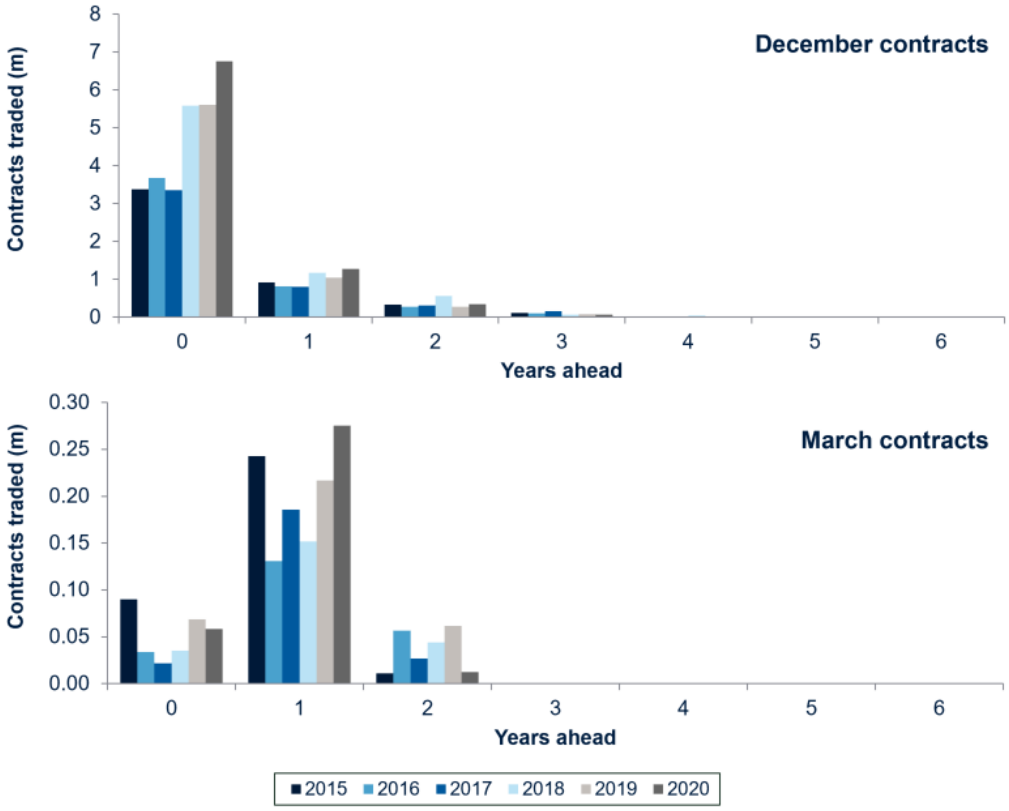
As discussed above, carbon prices provide an important pricing signal for investment decisions and effective risk management. The further out transparent and liquid contracts are available, the more informed the price discovery process is.

The more pricing points available, the longer the maturity on the longest-dated contract, and the more liquidity these contracts attract, the more risk management opportunities and information are available to market participants. The longest-dated contract available to participants seeking to trade EUA futures has increased slightly over time. In 2010, ICE offered trading in December contracts out to five years ahead.[62] In comparison, ICE currently offer trading in December contracts up to seven years ahead[63] and EEX offer trading in December contracts up to nine years ahead.[64]

Figure 4.8 shows how the volumes traded at different levels of the EUA pricing curve have changed over time. There has been a significant increase in the volume of trading for the front December contract (from around 3.4m contracts in 2015 to around 6.8m contracts in 2020). Volumes in the one- and two-year-ahead December contracts also increased in 2020 compared to 2015. This supports previous academic analysis, which also concluded that market efficiency had improved markedly over the period 2008–11.[65]

[62] ICE (2010), 'CE ECX Contracts: EUAs and CERs User Guide' May, https://www.theice.com/publicdocs/ICE_ECX_user_guide.pdf (accessed 30 December 2021).
[63] ICE (2021), 'ICE Endex EUA Futures', https://www.theice.com/products/197/EUA-Futures (accessed 30 December 2021).
[64] EEX (2021), 'EEX Futures Spot Product', https://www.eex.com/fileadmin/EEX/Markets/Environmental_markets/Emissions_Spot__Futures___Options/20200619-EUA_specifications_v2.pdf (accessed 30 December 2021).
[65] Ibikunle, G., Gregoriou, A., Hoepner, A.G.F. and Rhodes, M. (2012), 'Liquidity and market efficiency: European evidence from the world's largest carbon market', Working paper.

Figure 4.8 Number of contracts traded by contract month and year



Note: Bars refer to millions of contracts traded in the relevant calendar year in lots: 1 lot = 1,000 EUAs. A given number on the *x*-axis specifies the number of years on from the trading year. For example, '0' applies to the December or March contract for the year, '1' applies to a December or March contract expiring in the following year, and so on. Note the different scales of the *y*-axes for December and March contracts.

Source: Oxera analysis of ICE data.

The figure above also shows very limited trading activity in contracts expiring beyond three years into the future (despite them being offered by ICE). The lack of trading volumes in longer-maturity contracts may be linked to the underlying market design of EUAs (e.g. the fact that surplus allowances can be kept to cover future needs and the low storage costs associated with holding EUAs) and uncertainty regarding future rules. Ultimately, this suggests that users can meet their hedging needs through the contracts already offered by exchanges.

4.4 Evidence on liquidity

Another useful indicator of whether a market is functioning well is the overall liquidity, which is a significant component of the overall cost of trading. In general, one would expect a well-functioning market to exhibit low or falling costs of trading. Indeed, previous academic analysis of EUA futures found that trading costs fell substantially over the period 2008–11.[66]

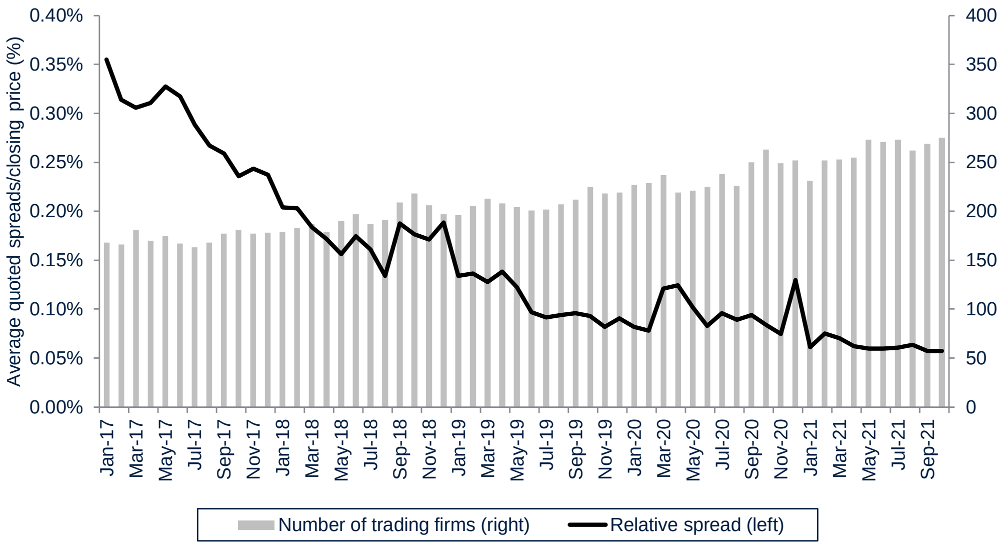
A common metric used to assess liquidity associated with a given financial instrument is the bid–ask spread. This measures the difference between prevailing best buy and best sell prices.

[66] Ibikunle, G., Gregoriou, A., Hoepner, A.G.F. and Rhodes, M. (2012), 'Liquidity and market efficiency: European evidence from the world's largest carbon market', Working paper.

There is a large body of academic literature showing how bid–ask spreads in a competitive market are determined by various trading frictions, such as order processing costs (e.g. the fees and overheads associated with executing and settling trades), inventory holding costs (when risk-averse traders holding a position are exposed to unfavourable fluctuations in prices), and adverse selection costs (the risk of trading with a more informed participant).[67] These costs are borne by market-makers and other liquidity providers, which will react to increases in these costs by demanding greater compensation through a wider bid–ask spread and/or reducing their propensity to trade (resulting in less market 'depth'). In markets with barriers to entry for trading participants, bid–ask spreads can also be wider due to limited competition between liquidity providers.

Figure 4.9 below shows that, as the number of trading participants in EUA futures have increased since January 2017, relative spreads (calculated as the average quoted spread divided by the closing price) in the benchmark December contract have come down significantly (from just under 0.4% to around 0.06%).[68]

Figure 4.9 Average daily relative spread for December EUA contract (%), January 2017–October 2021



Note: The quoted bid–ask spread is calculated as the difference between the quoted ask price and the quoted bid price. The average daily quoted spread is calculated based on a simple average of all new bid–ask spreads throughout the trading day. Due to data availability, relative spread is estimated by dividing the daily average quoted spread by the closing price. All bid–ask spreads relate to the nearest December monthly futures contract—for instance, for January–December 2018, the December 2018 contract is used. The number of trading firms is based on the number of firms that traded EUA futures in a given month (not necessarily the front December contract).

Source: Oxera analysis of ICE data.

[67] The first paper to relate bid–ask spreads to inventory risk was Stoll (1978). Glosten and Milgrom (1985) is a key paper relating to the adverse selection component of bid–ask spreads. See Stoll, H. (1978), 'The supply of dealer services in securities markets', *Journal of Finance*, **33**:4, pp. 1133–1151; and Glosten, L.R. and Milgrom, P.R. (1985), 'Bid, ask and transaction prices in a specialist market with heterogeneously informed traders', *Journal of Financial Economics*, **14**:1, pp. 71–100. For a discussion of the theory and literature, see Foucault, T., Pagano, M. and Roell, A. (2013), *Market Liquidity: Theory, Evidence, and Policy*, Oxford University Press.

[68] The same data shows that spreads have increased in absolute terms. This increase in absolute spreads is likely due to the twelvefold increase in prices of EUAs over same period. As prices of EUAs have risen, the absolute impact of price fluctuations (and therefore the inventory holding risk) will also increase.

The significant fall in relative spreads suggests that transaction costs for trading EUAs, as a proportion of the price, have come down over time. This change is likely to be linked to the significant growth in the number of trading firms, as shown in Figure 4.9, particularly as there was no significant sustained change in volatility since 2018, a key driver of inventory holding costs that is also reflected in the bid–ask spread (see Figure 4.9). As noted above, in general the more participants that enter the market wishing to buy or sell at or near the current price, the greater the competition for liquidity provision and the narrower the bid–ask spread.

5 How does derivatives trading affect carbon pricing?

This section explains how activity in derivatives markets affects carbon prices and describes the drivers behind the recent rise in carbon prices

5.1 What are the fundamental drivers behind the recent rise in carbon prices?

As discussed in section 2, the carbon price is ultimately based on the supply and demand of emissions allowances. The academic and policy literature identifies several factors that influence carbon prices. Specifically, the recent price increase can be attributed to high gas prices triggering a switch from gas-fired to coal-fired generation leading to greater emissions from the power sector, growth in demand for energy driven by COVID-19 economic recovery, and ETS policy reform aimed at achieving a progressively tighter cap on GHG emissions. This section expands on each of these drivers in turn.

5.1.1 Rising gas prices

Economic literature has also considered the impact of fuel-switching behaviour and the associated marginal abatement costs of power generators switching from coal to gas.[69] As noted in section 2.4, coal-fired generation produces more emissions than gas-fired generation, which, in turn, is more polluting than renewable electricity. In the last several years there has been a steady decline in the share of coal-fired power generation in Europe, but the reversal of this trend in 2021 goes some way to explaining the recent increase in demand for emissions allowances.[70]

Over the past decade, many countries have reduced their reliance on coal in order to meet emissions-reduction targets, and have thereby increased their reliance on gas and other generation technologies. Until 2020, European carbon prices would to some extent have been limited by the flat or falling demand for EUA by countries that were increasingly switching from using coal as a fuel for power generation to gas and renewable energy sources. However, since the end of 2020, a number of factors have reversed this, increasing the relative attractiveness of coal over gas as a fuel for power generation.

First, European gas production and pipeline imports have fallen consistently since 2017. Capacity limits on gas imports from Norway, together with operational supply disruptions and delays to the opening of new pipeline capacity (Nord Stream 2) from Russia, have also adversely affected EU gas supplies since late 2020.[71] In addition, a colder winter in 2020/21 in Europe and elsewhere resulted in significant reductions in gas volumes remaining in storage by summer 2020, and these were subsequently not replenished in time for the start of winter 2021/22.[72]

[69] See, for example, Keppler, J.H. and Mansanet-Bataller, M. (2010), 'Causalities between CO2, electricity, and other energy variables during phase I and phase II of the EU ETS', Energy Policy **38**:7, pp. 3329–3341.
[70] IEA (2021), 'Coal 2021: Analysis and forecast to 2024', pp. 6, 13. Available at: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/12/Insight-108-Supply-Side-Factors-in-European-Gas-Prices.pdf.
[71] Sharples, J. (2021), 'A series of unfortunate events: Supply-side factors in the European gas price rally in 2021 and outlook for the rest of winter', December, pp. 9, 10, 12, 13–16. Available at: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/12/Insight-108-Supply-Side-Factors-in-European-Gas-Prices.pdf. Chazan, G., Wilson, T. and Seddon, M. (2021), 'European gas prices rise after German concerns over Nord Stream 2', *Financial Times*, 13 December.
[72] Sharples, J. (2021), 'A series of unfortunate events: Supply-side factors in the European gas price rally in 2021 and outlook for the rest of winter', December, pp. 18–20. Available at: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/12/Insight-108-Supply-Side-Factors-in-

Second, worldwide demand for gas has also increased rapidly in recent years, which has resulted in upward pressure on the price of Liquefied natural gas (LNG). Countries such as China and India have seen gas as a way to reduce unacceptable levels of air pollution in cities that is primarily caused by coal use. In fact, Asia now accounts for 70% of global LNG imports. This longer-term trend combined with significant growth in demand for LNG in Asia and lower-than-expected growth in LNG supply in 2021 resulted in lower LNG volumes supplied to Europe in 2021.[73] Higher Asian LNG prices have therefore resulted in higher gas prices in Europe due to LNG increasingly being Europe's marginal source of gas.[74]

Given that gas and coal are substitutes for the production of electricity, and due to the more limited availability of gas and rising demand in Europe, the relative attractiveness of coal-fired power generation increased significantly in 2021 due to much higher gas prices and the relatively small increase in coal prices in 2021 (see section 1.1 and Figure 1.2). This therefore goes some way to explaining recent increases in carbon prices. Indeed, until recently, the benchmark December EUA contract had consistently traded below the price at which the least-efficient gas-fired power plants displace the most-efficient coal plants.[75]

5.1.2 COVID-19 recovery

Since 2020 there has been a general rise in demand for all energy sources as electricity demand has increased following a sharp recovery from the COVID-19 pandemic. Figure 5.1 below illustrates how the steep increase in carbon prices since January 2021 coincided with a time of rapid economic recovery enabled by the rollout of vaccination programmes. In contrast, the reverse happened following the 2007 financial crisis, where low economic activity resulted in low demand for energy and a drop in the carbon price. Economic growth is widely understood to be one of the drivers of carbon prices.

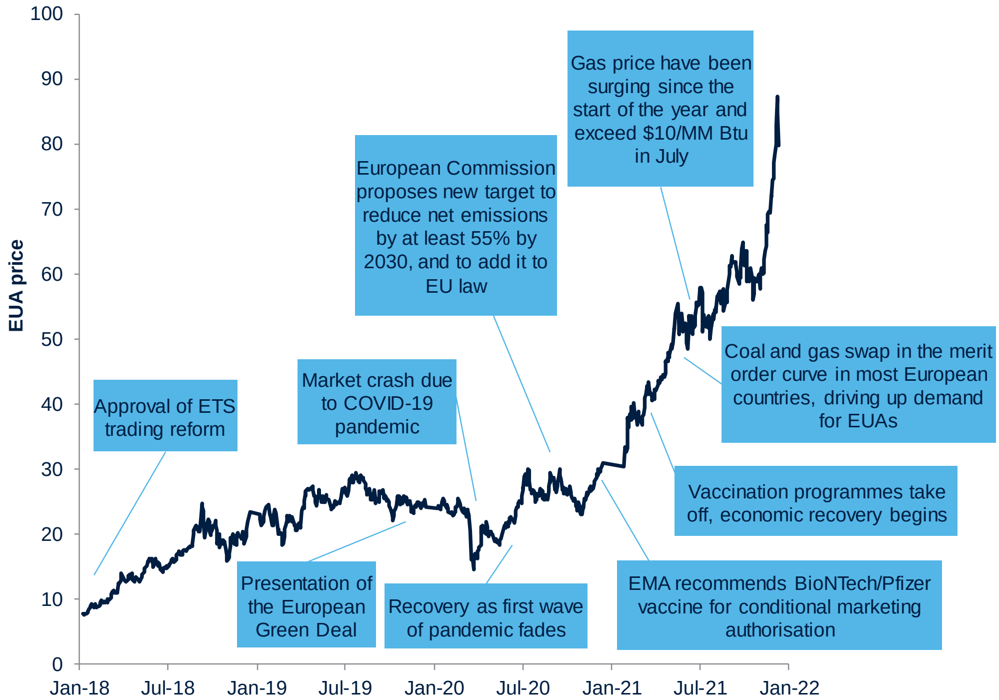
European-Gas-Prices.pdf (accessed 1 February 2022). Reuters (2021), 'On the cusp of Europe's winter season, gas storage hits 10-yr low', 23 September.

[73] Sharples, J. (2021), 'A series of unfortunate events: Supply-side factors in the European gas price rally in 2021 and outlook for the rest of winter', December, pp. 24–26. Available at: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/12/Insight-108-Supply-Side-Factors-in-European-Gas-Prices.pdf (accessed 1 February 2022).

[74] Sharples, J. (2021), 'A series of unfortunate events: Supply-side factors in the European gas price rally in 2021 and outlook for the rest of winter', December, pp. 23–24. Available at: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/12/Insight-108-Supply-Side-Factors-in-European-Gas-Prices.pdf (accessed 1 February 2022).

[75] Lewis, M. (2020), 'Deep decarbonisation: green hydrogen, net zero and the future of the EU-ETS', BNP Paribas, https://www.icef.go.jp/pdf/2020/program/plenary_session/MarkChristopherLewis_P.pdf (accessed 30 December 2021).

Figure 5.1 EU carbon price, 2018–21 (€)



Note: The y-axis unit is euros per tonne of CO_2e. This chart shows the EEX EUA primary auction settlement price. Data provided up to 10 December 2021.

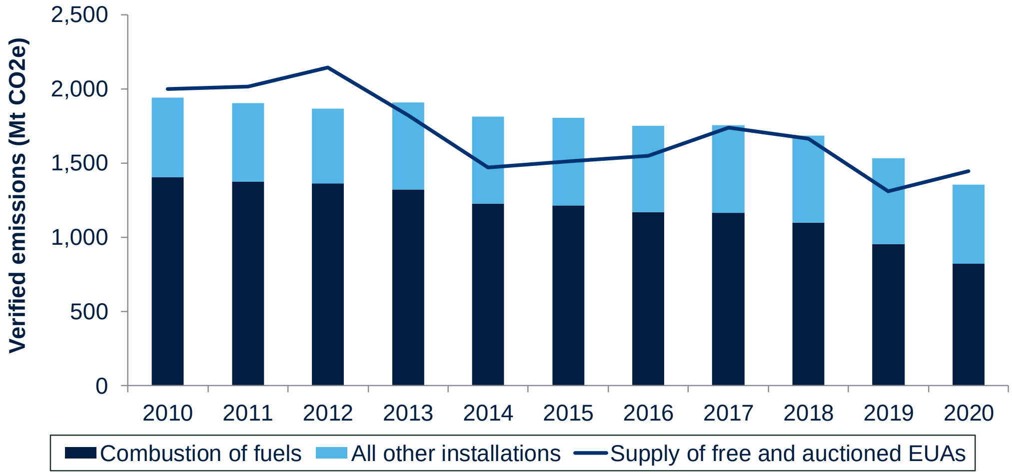
Source: Oxera analysis of ICE data.

5.1.3 ETS policy reform

While the demand for carbon allowances has been increased by the factors noted above, the supply of carbon allowances has simultaneously been decreasing over time. Under the Fit for 55 package, the supply of EUAs has been reduced further to achieve a higher rate of reduction in emissions by 2030. Moreover, the proposed expansion of the EU ETS to cover additional sectors such as maritime transport will further influence the expected demand and supply for EUAs in future, including potential 'pre-compliance' demand from emitters in sectors that will be covered by the EU ETS in future. Given that allowances purchased today can be used to meet EU ETS compliance requirements in any year until 2030, these policy changes could have a significant impact on the carbon price today (see sections 2.1.3 and 2.2).

As explained in section 2.1, the MSR is expected to steadily reduce the number of emissions permits available to market participants over time and these may not be reintroduced to the market in future years. Historically there has been an oversupply of permits in the market, with many given out free of charge, and the intention of the MSR is to correct for this oversupply. The EUA auctions are designed to ensure that the overall supply continues to be in line with long-term decarbonisation targets, and this may not be sufficient to meet demand, depending on the progress on emission reductions for the sectors covered by the EU ETS.

Figure 5.2 Verified emissions by installation type, 2010–20



Note: The y-axis unit is million tonnes of CO_2e, where 1 EUA = an entitlement to emit 1 tonne of CO_2e. Verified emissions refer to emissions of installations that are covered by the EU ETS. Data excludes the aviation sector. For further information, see: https://www.eea.europa.eu/data-and-maps/dashboards/emissions-trading-viewer-1 (accessed 30 December 2021).

Source: Oxera analysis of EU ETS data.

Furthermore, since the supply of EUAs is currently being re-assessed by the European Commission,[76] the price is also partly a reflection of market participants' expectations of the impacts of past and future regulatory decisions. In this pricing paradigm, carbon prices should reflect market participants' perceptions of the effectiveness and credibility of the design of the EU ETS, as well as their assessment of policymakers' commitment to ensuring that the supply of EUAs is engineered to deliver this outcome.[77] Indeed, this can be seen in Figure 5.1, with the prices rising after the EU ETS reform in February 2018 and after the European Commission first proposed revising the 2030 target in September 2020.

Policy uncertainty is therefore potentially a strong driver of the level and volatility of EU carbon prices. To the extent that recent EU ETS price developments (in terms of both price levels and volatility) have raised concerns over 'excessive speculation' (see section 5.3), it is important to consider the extent to which this could be the result of changes to fundamental price drivers (i.e. policy targets, abatement costs, and commodity prices), the greater participation of financial institutions in European carbon markets, and/or policy uncertainty.

The impact of policy uncertainty on EU carbon prices was recently investigated by Friedrich et al. (2020),[78] who analysed EU ETS policy changes. Specifically,

[76] European Commission (2021), 'Proposal for a Directive of the European Parliament and the Council amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union, Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading scheme and Regulation (EU) 2015/757', COM(2021) 551 final, 14 July. Available at: https://ec.europa.eu/info/sites/default/files/revision-eu-ets_with-annex_en_0.pdf. European Commission (2021), 'Proposal for a Decision of the European Parliament and the Council amending Decision (EU) 2015/1814 as regards the amount of allowances to be placed in the market stability reserve for the Union greenhouse gas emission trading scheme until 2030', COM(2021) 571, 14 July. Available at: https://ec.europa.eu/info/sites/default/files/revision-market-stability-reserve_with-annex_en.pdf. The current legislation in place is Directive 2018/410/EU. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0410&from=EN.
[77] Lewis, M. (2020), 'Deep decarbonisation: green hydrogen, net zero and the future of the EU-ETS', BNP Paribas, https://www.icef.go.jp/pdf/2020/program/plenary_session/MarkChristopherLewis_P.pdf (accessed 30 December 2021).
[78] Friedrich, M., Fries, S., Pahle, M. and Edenhofer, O. (2020), 'Rules vs. Discretion in Cap and-Trade Programs: Evidence from the EU Emission Trading System', Working Paper.

they looked at the development of the MSR in 2018 to test its impact on the stability of carbon prices while also accounting for changes in other fundamental price drivers.

A key finding of this research was that following the revisions to the EU ETS in March 2018, price formation for the December 2018 futures contract became untethered from market fundamentals until October 2018. In this period, the drivers of the EUA price, such as coal, gas and oil prices and equity indices, did not increase in importance as price determinants, nor did these drivers show the same growth behaviour seen in the EUA price.

Based on econometric tests for the identification of price bubbles, Friedrich et al. (2020) stated that there could have been an EUA price bubble between March and October 2018. It is notable that this period was also associated with significant increases in the volatility of the December 2018 future (i.e. the 'front year' contract at the time), as seen in Figure 5.5 (bottom panel). Referring to the nature and timing of policy announcements at the time, Friedrich et al. (2020) concluded that the evidence suggested that it was 'sentiment about the future scarcity of allowances [that] may have been the decisive factor'.[79] They also point out that that speculation that is induced by changes to the market design can serve a beneficial purpose of establishing a new equilibrium price.[80]

In light of this, it is notable that in 2021 the escalation in EUA prices (i.e. the front-year contract) was not accompanied by increases in volatility similar to those in 2018, as seen in Figure 5.5 (bottom panel). Indeed, with the exception of the spike in volatility associated with the start of the COVID-19 pandemic in early 2020, volatility in 2021 for the front-year contract has remained at the same relatively low level since mid-2019.

On balance, each of factors discussed in sections 5.1.1 to 5.1.3 has contributed towards the recent rises in carbon prices. Although policy reform restricting the supply of permits was expected to have an upwards effect on carbon prices, this has been exacerbated by the impact of increasing gas prices, which has contributed to a switch back to coal-fired power generation, and with it an increased demand for EUAs. These changes also come during a period of strong macroeconomic recovery as Europe emerges from the initial impact of the COVID-19 pandemic that has further increased demand for electricity generation.

5.2 What is the link between the carbon price and its derivatives markets?

When people refer to the EU carbon price, they are often referring to the price as traded on the primary market auction taking place on EEX. They may also, however, be referring to the price of EUA futures trading on derivatives exchanges, such as ICE. A natural question to ask is then: what is the link between these prices?

While the primary auction price is for the immediate purchase of an EUA, the price of an EUA future will largely reflect the expected price of an EUA at some future date. As explained in section 3.1, futures represent an agreement to buy or sell the underlying asset at a certain point in the future. A spot market transaction either in the primary auction or through the use of daily futures, represents the sale and purchase of an EUA today.

[79] Ibid., p. 36.
[80] Ibid.

For storable commodities, the relationship between spot and futures prices is due to the possibility of arbitrage opportunities. Financial theory dictates that as the futures contract approaches maturity, the difference between the spot price and the futures price should converge, as the two contracts become economically identical. Before maturity, the price differential is driven by the opportunity cost of the money paid for the spot allowance and the possibility of arbitrage opportunities.

In the case of most commodities, this arbitrage opportunity is driven by the economics of storage (also called the 'cost of carry').[81] The owner of a commodity may benefit from owning the physical commodity and therefore having easily accessible inventory (e.g. the ability to maintain production despite shortages or fluctuations in supply). This is known as the 'convenience yield'.

When the futures contract price is above the spot price, the market is in 'contango'. When the futures price is below the spot price, the market is in 'backwardation'.

A number of features unique to EUAs are relevant to the relationship between spot and futures prices, including the following.

- There is effectively only one 'physical' supplier in the primary market for EUAs: the government.[82] As there is only one supplier and many natural buyers (compliance entities), this makes the role of financial intermediaries even more important for liquidity provision.
- The cost of storage is low since an EUA is just an accounting entry in the EU registry system. The main costs of holding an EUA comprise the fees payable to cover the costs of the national administrator, as well as the costs involved in managing the user's electronic account (overheads plus the cost of capital). As indicative examples, in 2020 the annual fees levied by the French administrator ranged from €250 to €950 per account while the German administrator charged €170 to open an account and €600 as an account administration fee for the entire trading period.[83]
- Transport costs for EUAs are low as an EUA can be transferred to another party electronically by the authorised account holder. There are some restrictions on transfers, and certain transfers may take longer to process.[84]

[81] The arbitrage opportunity is as follows: the trader initially borrows money and uses it to buy an asset in the spot market and sells the commodity forward. Trader then stores asset (for a fee) until the point when futures contract expires. At expiration trader must pay back the borrowed money plus interest and storage costs. If the forward price exceeds the net amount owed, then the trader would be able to make a risk free profit. If this were the case, traders would buy spot and sell futures such that the basis disappears. Assuming you can short the spot market, same property holds in reverse.
[82] EUAs issued by EU member states and EEA countries are currently auctioned through a single platform. See: https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets/auctioning_en#ecl-inpage-441.
[83] French Ministry for the Ecological Transition (2020), 'Decree of December 21st, 2020 establishing for the year 2020 the amount of the account management fees for account holders pursuant to Article R 229-36 of the French environment Code', 21 December, available at https://www.seringas.caissedesdepots.fr/sites/www.seringas.caissedesdepots.fr/IMG/pdf/5.en_fees2020.pdf (accessed 1 February 2022). See also Deutsche Emissionshandelsstelle (2022), 'European emissions trading', available at https://www.dehst.de/EN/european-emissions-trading/union-registry/account/account_node.html (accessed 1 February 2022).
[84] Accounts held by operators (i.e. operators of emitting installations/aircraft) may only transfer EUAs to accounts that they have identified as 'trusted'. Accounts held by traders may transfer EUAs to any account. Transfers to an account which has been identified as 'trusted' by the holder of the EUA are executed immediately. Transfers to other accounts are subject to a delay of approximately one day. See Article 35 and 55 of CDR 2019/1122.

Some national administrators levy fees to cover the costs of processing transactions.

- An EUA is fungible across time periods within phases of the EU ETS, and is currently expected also to be fungible across future phases. The EUA does not depreciate in quality over time.
- There is no additional benefit from holding an EUA beyond compliance. In contrast to financial assets and other commodities, there are no additional expected payoffs (e.g. dividends).[85]
- An EUA is really needed only at certain times in the year that correspond to the compliance timetable. Key dates are 31 December, the last day of the compliance year, and 30 April, when the compliance entities need to report and then submit their emission allowances for the previous calendar year.

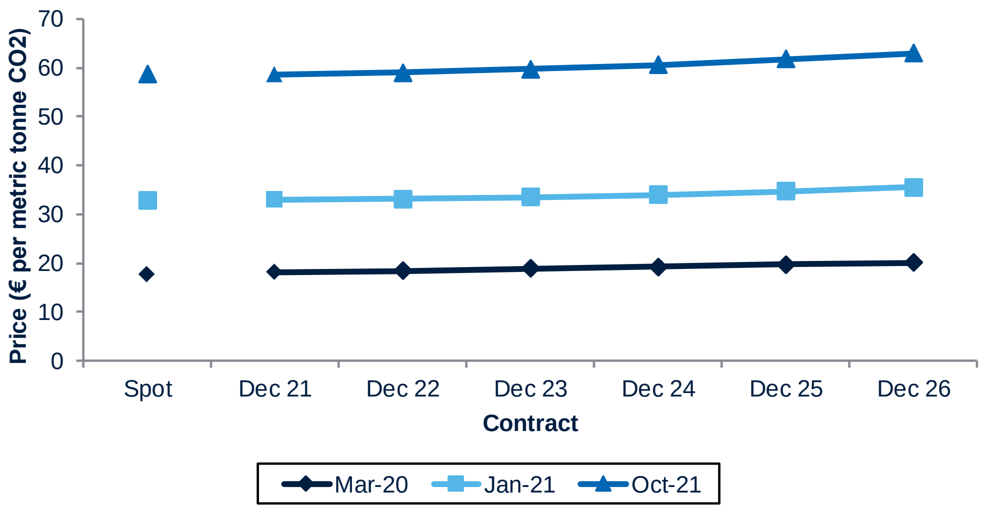
With EUAs bankable across EU ETS phases and compliance periods, the EUA futures curve should in theory reflect the market's assessment of the price at which sufficient emissions would be abated such that the emissions cap established by the EU ETS is met. Put differently, if the market is functioning efficiently, today's EUA price should in principle reflect expectations of the future cost (in €/tCO_2e) required to deliver the last units of emissions reductions, adjusted for the cost of capital. In practice, the total quantity of emissions reductions needed to meet the long-term policy goal and the cost of the marginal emissions reductions that would be required remains highly uncertain. However, recent forecasts indicate that EUA prices are expected to range between €90/tCO2e and €129/tCO2e in 2030 (see section 2.4.5). As discussed in section 5.1.3, in the short to medium term, EUA prices will also be influenced by market participants' perceptions of policymakers' commitment to ensuring that the supply of EUAs continues to be constrained such that the EU remains on track to meet its decarbonisation objective.

So far, as noted by ESMA and the European Central Bank (ECB) in the recent assessments, EUA futures prices have been relatively flat, albeit slightly upward-sloping, as shown in Figure 5.3. The ECB stated that the slope of the curve may shift in the future, particularly if market participants become concerned that regulators may restrict the right to carry over allowances from one year to the next.[86]

[85] In the case of many commodities, there is often a benefit associated with holding the physical commodity. For example, having immediate, physical access to a commodity like corn, wheat or oil held in storage at times of constrained supply (relative to demand) avoids the opportunity costs of not being able to meet demand.

[86] ECB (2021) 'Economic Bulletin', Issue 6/2021, Box 5. See also Bredin, D. and Parsons, J. (2016), 'Why is Spot Carbon so Cheap and Future Carbon so Dear? The Term Structure of Carbon Prices', *The Energy Journal*, **37**:3.

Figure 5.3 EUA future curve



Note: The y-axis unit is euros per tonne of CO_2e. Prices as at last trading day of given month.

Source: Oxera analysis of ICE data.

In sum, the spot and futures market prices are closely linked. Both are predominately driven by market fundamentals, meaning factors affecting the demand and supply of the underlying EUAs.

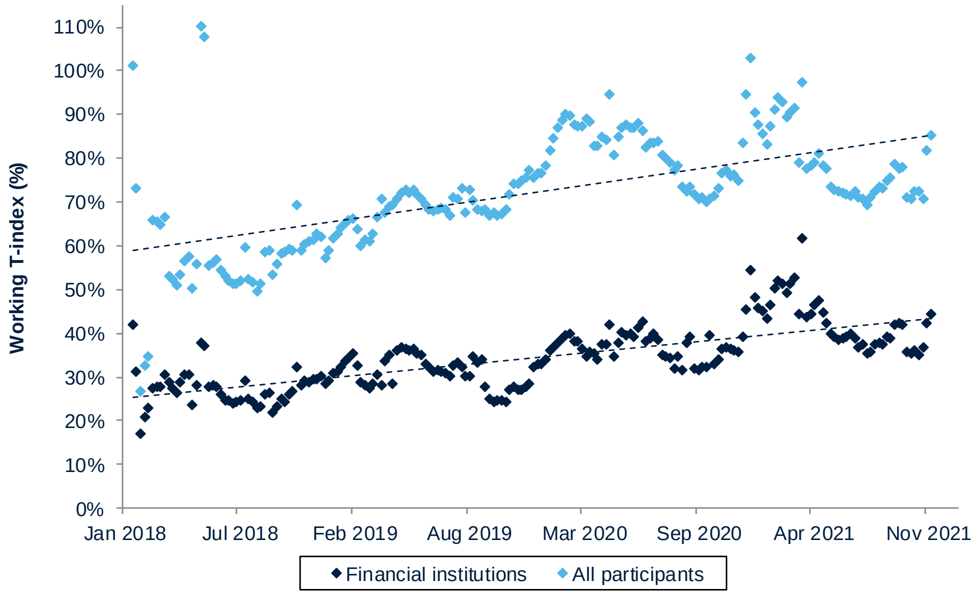
5.3 What is the impact of speculative trading on carbon pricing?

As discussed in section 3.4, speculators play an important role in carbon markets by providing liquidity and taking the other side of the trade to natural hedgers, as shown in Figure 4.6 and Figure 4.7.

While carbon markets cannot function without the presence of speculative trading, some concerns have been raised regarding the potential risk that 'excessive' speculation in EUA futures by financial institutions may lead to a carbon bubble (i.e. EUA prices and volatility being higher than the underlying fundamentals can justify). For example, Quemin and Pahle (2021)[87] analyse publicly available position reports and compute a metric of 'excess' speculation called the 'Working T-Index'.[88] The authors show that T-index values increased from around 50% to 90% of total hedging volumes from 2018 to 2020, and have fluctuated between 70% and 90% since then (see Figure 5.4 below). The same authors also identify an increase in the volume of open interest in front December contracts listed on EEX, which they interpret as another indicator of speculative activity.[89]

[87] Quemin, S. and Pahle, M. (2021), 'Financials threaten to undermine the functioning of emissions markets', Working Paper.
[88] In a market where net hedging is long The Working T-index reflects the total volume long positions that are not made for hedging purposes, expressed as a percentage of total (long and short) hedging volume. See Working, H. (1960), 'Speculation on hedging markets', *Food Research Institute Studies*, **1**:2, pp. 1–36.
[89] Here, the authors argue that hedging activity will be concentrated in longer maturity contracts. This means that front year open interest remains roughly flat over time, as front year hedges will mostly be provisioned in earlier years. The authors suggest that significant increases in front year open interest point to excessive speculation, as speculative trading will concentrate on the most liquid contracts since it is easier to adjust positions.

Figure 5.4 Working T-index values on ICE EUA futures (%), January 2018–November 2021



Note: Working T-index values are calculated as 'other' short positions in excess of net hedging (risk-reducing long positions minus risk-reducing short positions). Market balance implies that this is equivalent to 'other' long positions. Values are expressed as a proportion of total hedging (risk-reducing long positions plus risk-reducing short positions). Separate values are presented for speculation by financial institutions (investment firms, investment funds and other financial firms) as well as by all market participants.

Source: Oxera analysis of ICE COT data.

A high T-index value does not by itself provide evidence that a market is characterised by 'too much' speculation. As explained in section 3.4, the distinction between speculation and hedging is not always clear-cut. For example, emitters that are not currently within the scope of the EU ETS seek to hedge their carbon footprint by trading EUAs in anticipation of the scope of the EU ETS expanding in the future or for ethical reasons. In either case, it may not be obvious whether such trading is 'risk-reducing' or 'speculative'.

Moreover, the correlation between the T-index and price changes of EUA futures is near zero: around -0.01 for the front-year contract between January 2018 and November 2021.[90] From a public policy perspective, the key question is how speculation affects market quality (e.g. through excessive prices or volatility).

To better understand the potential effect of speculative trading, the following subsection provides a recap of the main insights from the academic literature. Given the unique features associated with EUA markets, as discussed in section 5.2, it is also helpful to consider how EUA and EUA futures price volatility has evolved over time.

[90] Oxera analysis of ICE data. This finding is consistent with research on other commodities that finds a similar result. See, for example, Buyuksahin, B. and Harris, J.H. (2011), 'Speculators, prices and market volatility', Working paper; and Alquist, R. and Gervais, O. (2013), 'The role of financial speculation in driving the price of crude oil', *The Energy Journal*, **34**:3, pp. 35–54.

5.3.4 How does speculative trading affect carbon price volatility?

Speculative trading (i.e. traders taking a position on the future direction of a market variable) may affect price volatility in one of two ways.

- Speculators may trade primarily on the basis of proprietary information. This means that, due to their trading activity, prices adjust more quickly to reflect fundamental value drivers (i.e. the activity leads to lower volatility).[91] A naïve speculator would go bankrupt very quickly.
- Speculators entering the market increase competition for liquidity provision. Improved liquidity for a given asset may, in turn, lead to reduced volatility (for example, as incoming orders are less likely to absorb all the resting quotes on the other side of the order book).

Several academic papers have empirically tested the relationship between speculative trading and price volatility in commodity markets (see Table 5.1). Overall, much of this empirical literature suggests that speculators tend to dampen (not increase) price volatility (as well as contributing to liquidity, as discussed in section 4.4).

Table 5.1 Literature review on speculators and price volatility

Paper	Key findings
Gilbert (2010)	Gilbert uses data on index fund positions in the US agricultural futures markets as a proxy for total index-related futures positions in all markets. Granger causality tests using this proxy measure suggest that index investors may amplify fundamentally driven price movements.
Irwin and Sanders (2011)	Irwin and Sanders test whether the growth in index funds has increased price volatility in agricultural and energy markets. To do so, they conduct a Granger causality test between measures of traders' positions and speculation against volatility of returns. They find no evidence to suggest that index funds caused a price bubble in agricultural commodity markets.
Buyuksahin and Harris (2011)	Buyuksahin and Harris test the correlation between the Working T-index and daily price changes in the crude oil market. They report a near zero correlation between the two series.
Brunetti, Buyuksahin and Harris (2011)	Brunetti et al. consider specific categories of traders and test whether positions taken by each cause changes in volatility in oil prices. They conclude that the results are consistent with speculators providing liquidity and responding to market conditions, rather than the opposite.
Alquist and Gervais (2013)	Alquist and Gervais find that financial firms' positions did not cause oil price fluctuations during 2007/08. They use the Working T-index to examine the importance of financial firms in driving oil price volatility and find no empirical evidence to suggest a strong relationship between the position of speculators and price changes.
Bohl, Putz and Sulewski (2021)	Bohl et al. conduct a fixed-effects panel regression across 20 commodity markets. This model finds no evidence of a significant relationship between speculative activity and the degree of informational efficiency, after controlling for volatility and liquidity.

Source: Gilbert, C. (2010), 'Speculative influences on commodity futures prices, 2006-2008', UNCTAD Working Paper; Irwin, S.H. and Sanders, D.R. (2011), 'The impact of index funds in commodity futures markets: a systems approach', *Journal of Alternative Investments*, **14**, pp. 40–49; Buyuksahin, B. and Harris, J.H. (2011), 'Do speculators drive crude oi futures?', *Energy Journal*, **32**, pp. 167–202; Brunetti, C., Buyuksahin, B. and Harris, J.H. (2011),

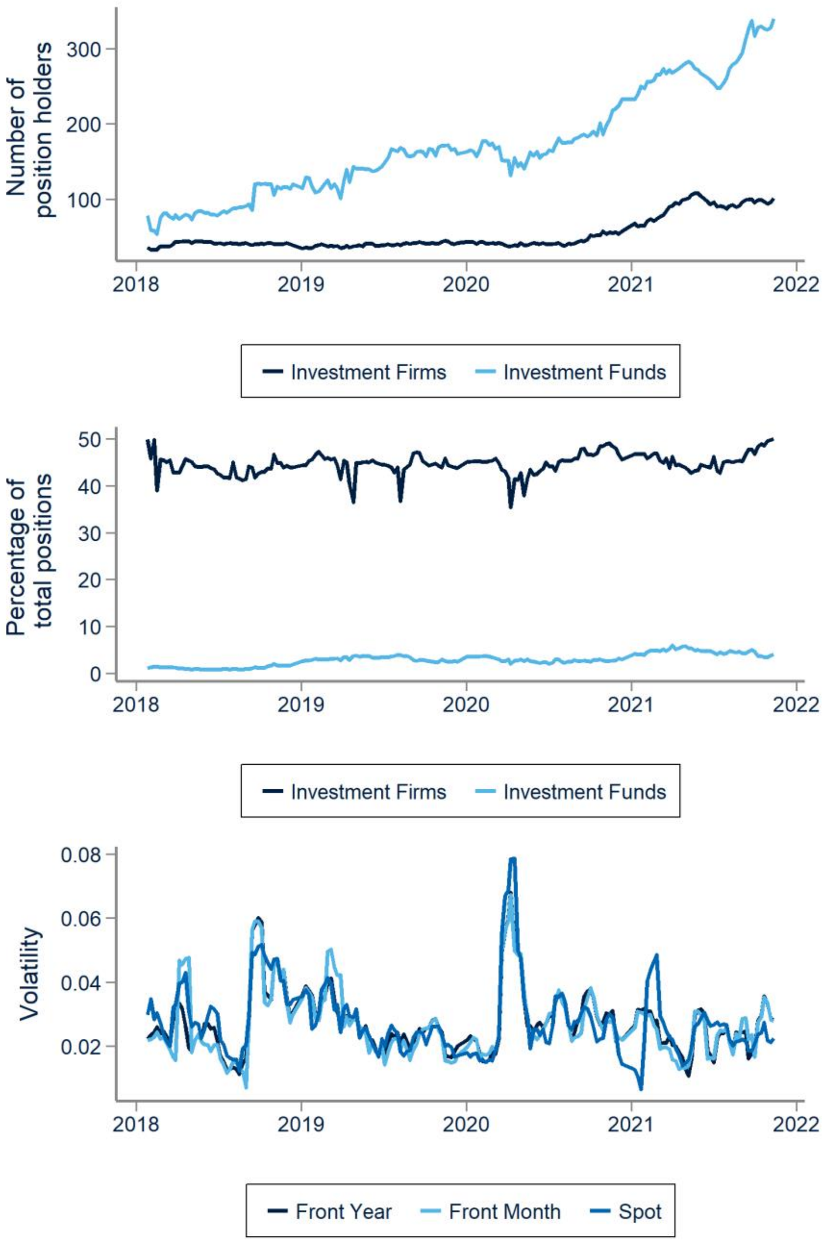
[91] For a market microstructure model that shows how prices adjust to reflect the trading behaviour of informed traders, see, for example, Glosten, L.R. and Milgrom, P.R. (1985), 'Bid, ask and transaction prices in a specialist market with heterogeneously informed traders, *Journal of Financial Economics*, **14**:1, pp. 71–100.

‘Speculators, prices and market volatility’, Working paper; Alquist, R. and Gervais, O. (2013), ‘The role of financial speculation in driving the price of crude oil’, *The Energy Journal*, **34**:3, pp. 35–54; Bohl, M.T., Putz, A. and Sulewski, C. (2021), ‘Speculation and the informational efficiency of commodity futures markets’, Working paper.

As none of these papers considered carbon markets specifically, it is useful to test the relationship directly using actual data on EUA prices.

Figure 5.5 shows how volatility in EUA prices on ICE changes, as the number of position holders increases over time. Overall, this data suggests that despite an increase in the number of position holders and a slight increase in the share of positions held by financial firms, price volatility has not increased.

Figure 5.5 Relationship between volatility and trading activity of financial institutions



Note: The y-axis unit for the second and third chart is percentage. The percentage of total positions refers to the size of the positions held by investment firms and investment funds, respectively, in EUA futures as a proportion of total positions on EUA futures in the weekly COT reporting period. Volatility is the standard deviation of daily returns based on a 21-day rolling window. The front-year contract refers to the contract settled in December of the respective calendar year. Similarly, the front-month contract refers to the contract settled at the end of the respective calendar month. Similarly, here 'Spot' refers to the last available EUA auction price.

Source: Oxera.

An indication of the underlying relationship can be seen more clearly by looking at the correlations between each of the time series presented above. As Table 5.2 shows, the correlation between EUA auction price volatility and the number of position holders and the share of positions held by financial firms respectively is negative (and statistically significant) in all cases. This result is in line with what would be expected based on our literature review in the case of other commodities. However, it is worth noting that the magnitude of the correlations is low, indicating that the negative relationship is not particularly strong.

Table 5.2 Correlations between EUA volatility and the trading activity of financial institutions

	Volatility of EUA…		
	Auction price	Front-month future	Front-year future
Number of investment firms holding positions	-0.23*	-0.20*	-0.22*
Number of investment funds holding positions	-0.25*	-0.16*	-0.16*
Δ of number of investment firms holding positions	-0.07	-0.08	-0.05
Δ of number of investment funds holding positions	-0.05	-0.04	-0.03
Number of positions held by investment firms	-0.02	0.05	0.08
Number of positions held by investment funds	-0.26*	-0.19*	-0.19*
% of positions held by investment firms	-0.24*	-0.10	-0.13
% of positions held by investment funds	-0.24*	-0.20*	-0.21*
Working T-index	-0.08	-0.03	-0.01

Note: The data on positions is available on a weekly basis. Volatilities on the reporting days (every five working days) are used to compute correlations. The superscript * indicates a p-value of less than 0.05.

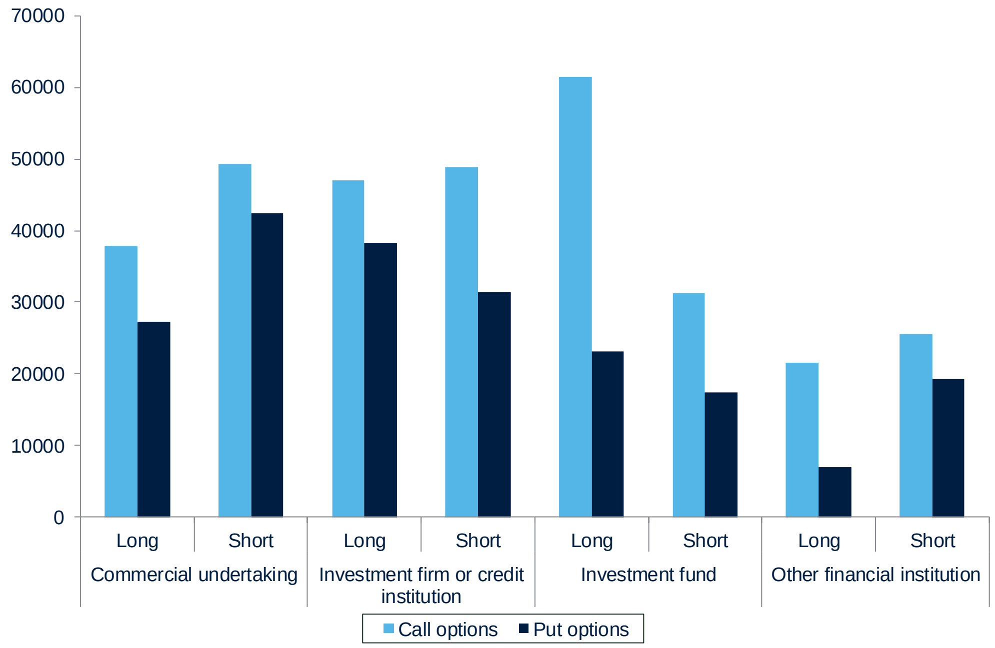
Source: Oxera.

5.3.5 How does options trading affect carbon prices?

While fundamentals over recent months have pushed up the prices of EUAs, there has also been increased activity in options trading.

Options are widely used financial instruments by all trader categories, as shown in Figure 5.6 (below), as part of prudent risk management and/or as a cost-efficient way to establish positions. Options can be a cheaper way for a market participant to establish a position on EUAs than the futures market.

Figure 5.6 Positions on EUA Options as at 1 October 2021, by trader category



Note: The y-axis unit is number of lots: 1 lot = 1,000 EUAs. EUA options are European-style options on the EUA futures contract, such that upon expiry automatic exercise will occur of options that are in the money (out-of-money options will expire). The underlying contract is the December future of the relevant year. For example, the underlying variable for the March 2021 option is the December 2021 Future. The choice of reporting the positions on the date of 1 October 2021 was arbitrary and timely at the point of the data request to ICE.

Source: Oxera analysis of ICE data.

In recent months there have been reports of increased activity in EUA options trading. For example, open interest in call option contracts with expiry in December of the same year rose from around 188m EUAs in mid-November 2020 to around 351m EUAs in mid-November 2021. At the same time, the share of in-the-money call options has doubled from 25% to 50%. In spite of the evidence linking fundamentals to the rise in the price of EUAs, as discussed in section 5.1, some commentators have questioned whether options trading may have also contributed to the increase in EUA prices.[92]

The impact of options trading on the carbon price depends on how the seller of, say, a call option is hedged and what the participant exercising an option wants to do with the EUAs afterwards.

Trading activity in call options could have implications for underlying futures prices if increases in call option open interest (see Figure 5.7) lead to additional buying of EUA futures as a hedge.

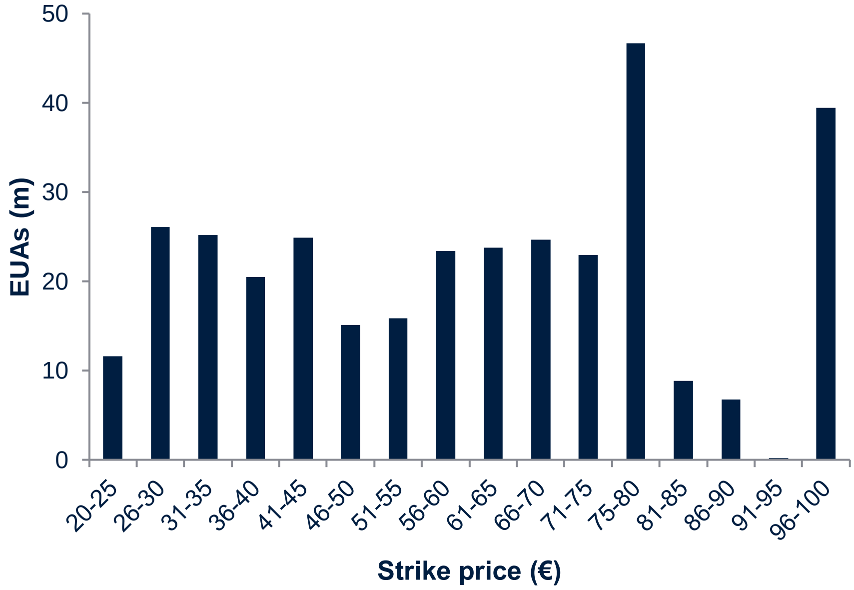
There might be upward pricing pressure if the option exercised were not hedged and the hedging provider needed to buy EUAs in the primary market to ensure delivery of the contract. In contrast, there could be downward pricing pressure if the option being exercised was previously hedged and/or if the trader exercising the option chose to sell their EUA back in the open market.

[92] See for instance Evans, M. (2021), 'Spotlight: EU carbon price strengthens to record highs in November', *SP Global Platts*, 8 December; Carbon Pulse (2022), 'Key EU lawmaker plans to propose steps to curb carbon market "manipulation", 14 January.

Feedback from interviews with EU carbon traders indicates that many of the December 2021 call options that were in the money were the result of positions taken at the start of the year in anticipation of the EU tightening its climate objectives ahead of COP26 and the publication of the Fit for 55 package.

While the evidence in section 5.1 shows clearly that fundamental demand and supply factors have put upward pressure on the price of EUAs, we have not seen any evidence that suggests that options on EUAs have amplified this effect. Indeed, if many of the options that are now in the money were well hedged, the effect could have been the reverse.

Figure 5.7 EUA call option open interest for December 2021 contract



Note: The y-axis unit is millions of EUAs call option open interest for the December 2021 contract, the x-axis is euros per tonne of CO_2e. Data extracted from webplotdigitizer.com.

Source: Oxera analysis of S&P Global analysis using data provided by ICE and Platts Analytics.

The discussion above supports the view that speculators play an important and positive role in the functioning of the market for trading EUA futures and options.

6 Policy implications

The European Commission has asked ESMA to consider whether there is a need for targeted action in the EU carbon market. This section summarises the key findings and policy implications of the analysis presented in the previous sections.

A well-functioning carbon trading market plays an important role in the delivery of the EU's decarbonisation goals. In particular, it provides transparent price signals that allows participants to allocate capital and manage risk efficiently in the face of the uncertainties that surround the energy transition. This function will continue to be critical in helping achieve an efficient transition to the net zero objective.

The evidence presented in this report indicates that the market is functioning well and as expected. Over time, the trading of EUA futures has developed from an OTC market to a predominately exchange-traded one. This shift has had a positive impact on end-users. In particular, as exchanges have been successful in attracting a more diverse group of market participants, exchange-trading has led to improvements in market resilience, price formation and liquidity.

Most trading takes place between entities seeking to hedge their EUA price and volume risks with financial institutions and other liquidity providers on the other side of the trade, who are willing to provide quotes by earning the spread and by taking a position. While there has been an increase in the number of funds investing in the carbon market, the size of their positions remains relatively small. All of these market participants are providing important contributions to the well-functioning of the market.

The success of the EU carbon trading market up until this point is largely due to the EU's policy ambition to date, as well as the activities of financial market participants and infrastructure providers.

Emissions trading is now a well-regulated market in the EU. In addition to the detailed rules set out in the EU regulatory framework, the exchanges operate within a comprehensive market monitoring and compliance framework, to ensure that trust and confidence remains in the market

There have been some calls for regulators to impose position limits on EUA futures. Evidence from other markets suggests that applying inflexible position limits within legislation may be counterproductive, particularly as the market is currently functioning well. It would be better to leave exchanges to monitor trading in carbon markets and to take appropriate measures in response to market developments in real time, under the close supervision of the NCAs. That said, it would be helpful to improve the consistency across the EU of the reporting of positions by entities as part of the COT reports. Further guidance from ESMA to reporting entities may help.

Market surveillance and monitoring could also be further improved via better coordination and data sharing arrangements between the central and national administrators of the Union Registry for the holdings of EUAs and the relevant financial regulators.[93]

[93] Article 67(1) of Commission Delegated Regulation (EU) 2019/1122 of 12 March 2019 supplementing Directive 2003/87/EC of the European Parliament and of the Council as regards the functioning of the Union Registry provides that 'the central administrator and the national administrators shall cooperate with public

Despite some concerns raised about the recent increase in prices, there is little evidence to suggest that the price level is above that implied by the fundamentals. It is worth recalling that the EUA price is established in a market driven entirely by policymakers and legislation. According to many forecasters, the EUA price today is, in fact, lower (not higher) than where it needs to be to reach the EU's decarbonisation targets.

It is important that any policy action does not undermine the success of the EU's climate policy action to date and developments in the market infrastructure around carbon trading in the EU in recent years.

Where it is suggested that anomalous price movements have occurred, these are best explained by a combination of changes, such as the introduction of more ambitious emission reduction targets, revisions to the MSR, and changes to other market fundamentals (e.g. changes to expected abatement costs, including the relative prices of gas and coal).

Given the likely expansion of the EU ETS to other sectors in the coming years, it will be important to communicate policy changes clearly and not undermine the work already done. Indeed, after many years of investment, the EU ETS is now seen as a global benchmark for carbon trading, and a success story that other regions are seeking to follow.

There is also merit in encouraging wider use of risk management and hedging among firms exposed to volatility in carbon prices. Failure to manage these risks appropriately could expose European households and companies to unnecessary price shocks during the transition to a low-carbon economy and risk the EU missing its legally binding decarbonisation targets. Hedging incentives can be put in place by, for example, removing free allowances as soon as possible.

bodies charged with the supervision of compliance under Directive 2003/87/EC and public bodies competent for the oversight of primary and secondary markets in allowances in order to ensure that they can acquire a consolidated overview of allowances markets'. We understand that this is insufficient to afford ESMA and the relevant financial regulators direct access to data on investors' holdings in EUAs on an ongoing basis.

A1 EU regulatory framework on carbon trading

This appendix summaries the key pieces of EU regulation covering the trading of EUA futures and EUA options.

A1.1 Carbon markets under the EU's second Markets in Financial Instruments Directive (MiFID II) and Markets in Financial Instruments Regulation (MiFIR)

- With MiFID II, emission allowances have become financial instruments under Annex I, Section C (11). In contrast to energy markets, spot markets of emission allowances do not fall under the realm of REMIT.
- Despite being subject to weekly and daily position reporting, derivatives on emission allowances do not fall under the definition of commodity derivatives under MiFID II and are therefore not subject to position limits and position management controls.
- EUAs and the derivatives on EUAs need to be reported to the national competent authorities (NCAs) as of January 2018, according to MiFiR. The transaction data provided under MiFID is one of the tools that enables NCAs to systematically monitor for abuses under the MAR.[94] In addition, the order data collected in accordance with MiFIR is important to detect market manipulations; however, this order data information is not included in the transaction reporting, and NCAs will have to gather such data through requests to the trading venues.
- There are particular rules governing which transactions in financial instruments related to EUAs are covered by MiFiR—see paragraph 17 of ESMA report for more information.[95]
- Since January 2018, for EUAs and derivatives traded on EEX and Nasdaq Oslo, the NCAs are BaFin and FIN-NO respectively. For derivatives on emission allowances traded on ICE, the relevant competent authority since January 2018 has been the UK Financial Conduct Authority, while the AFM took over the responsibility after the migration of trading from the UK ICE Futures Europe to the Dutch entity ICE Endex in June 2021.

A1.2 Carbon markets under the EU's Market Abuse Regulation (MAR)

- The MAR is aimed at promoting integrity of the markets through the prohibition of insider dealing, unlawful disclosure of inside information and market manipulation. In addition to these prohibitions, MAR provides for ancillary rules to be followed by issuers and intermediaries in an attempt to prevent market abuse, and for significant powers for NCAs in the detection and prosecution of breaches.
- The MAR applies horizontally to all financial instruments admitted to trading on an EU-regulated market or traded on an MTF or OTF, including EUAs.
- The MAR provides that emissions allowance market participants should disclose, timely and in the public domain, the inside information which they hold about their activities. The MAR expressly prohibits placing orders,

[94] See Recital 32 of MIFIR states that "The details of transactions in financial instruments should be reported to competent authorities to enable them to detect and investigate potential cases of market abuse, to monitor the fair and orderly functioning of markets, as well as the activities of investment firms.
[95] ESMA (2021), 'Preliminary report: Emissions Allowances and derivatives thereof', ESMA70-445-7, 15 November, https://www.ESMA.europa.eu/sites/default/files/library/ESMA70-445-7_preliminary_report_on_emission_allowances.pdf (accessed 30 December 2021).

entering into transactions or disseminating information through the media that give false or misleading signals as the supply, demand or price of a financial instrument, or that are likely to secure its price at an abnormal or artificial level. Individual or concerted actions aimed at securing a dominant position over the supply of, or demand for, a financial instrument are also prohibited.

- The buying or selling of EUAs or related derivatives on the secondary markets is also considered market manipulation whenever it has the effect of creating or maintaining an artificial price for the auctioned products, or where it misleads bidders in the auctions. The auction prices and secondary market prices are interrelated, as the auction should be cancelled according to Art. 7 (6) of Regulation 1031/2010 if the auction clearing price is significantly below the price on the secondary market. This aims to prevent market participants from benefitting from arbitrage between the primary and secondary markets.
- To ensure prevention and detection of market abuse, the MAR provides that market operators, investment firms operating a trading venue, and any person professionally arranging and executing transactions, are to establish arrangements, systems and procedures to detect and report to NCAs suspicious orders and transactions (STORs)—including EUAs and derivatives. In addition to the ex post mechanism, market operators and investment firms are obliged to establish and maintain effective systems and procedures in order to prevent market abuse.
- Trading venues are required to have effective procedures in place to maintain a fair and orderly market. ICE, for example, applies real-time and T+1 monitoring, and is expected to submit STORs whenever it notices suspicious trading behaviour on its platform. The AFM organises periodic market conduct meetings with ICE Endex, where alerts generated by the automated surveillance system are discussed in detail. Upon request, ICE Endex shares EUA derivatives order data with the AFM to support thematic market surveillance investigations.

A1.3 Carbon markets under the EU's European Market Infrastructure Regulation (EMIR)

- The EMIR was established in the aftermath of the 2009 financial crisis to make the OTC derivatives market more transparent, reduce systemic risks, and prevent market abuse. The EMIR contains an obligation to report detailed information upon the conclusion, modification or termination of any derivative contract (both OTC and exchange-traded derivatives)—including EUA derivatives—to trade repositories (TRs).
- The EMIR sets reporting obligations for all financial counterparties, which include investment firms, credit institutions, insurance undertakings, and non-financial counterparties that trade in EUA derivatives. This thereby improves the transparency of EUA derivatives trading.

A2 Literature review on the impact of position limits on market functioning

In cases of extreme volatility and/or to pre-empt market manipulation, exchanges may apply position limits or circuit breakers.[96] They only do this where it is appropriate, depending on the specific circumstances of the trading environment and the characteristics of the underlying commodity. Violating these limits typically results in disciplinary action by the exchange.

The rationale behind imposing positions limits is to prevent speculators from gaining power to exert undue influence on the market, thereby ensuring efficiency and authenticity in price movements. Position limits are generally construed as a proactive mechanism to curb market manipulation. This contrasts to circuit breakers, which are reactive.

The economics literature is quite sceptical about the benefits of regulators (rather than exchanges) imposing position limits on market participants in futures markets, despite the good intentions of the regulators to ensure efficiency and price formation.

Many studies argue that government regulation of manipulative practices in financial markets is superfluous, as trading venues themselves are incentivised to take precautions against the exercise of market power.[97] In particular, the core business model of a trading venue is to maximise order flow, by attracting market participants to submit bids. The more authentic the price movements, and greater the market integrity, the more likely the exchange is to attract order flow. This is why exchanges invest in activities to manage and monitor trading behaviour and positions in a manner that ensures market integrity, while minimising potential impacts on market efficiency, liquidity and price discovery (as discussed further in section 3.2 in the main report). As noted by ESMA the use of instruments, such as circuit breakers, by trading venues to interrupt excessive prices are effective if they address transitory volatility (defined as the tendency for prices to fluctuate around their fundamental value). However, ESMA also noted that circuit breakers are not effective if they address fundamental volatility. In this case a trading halt prevents prices from reflecting the new information on fundamental values. [98] A key risk of regulators embedding hard-coded position limits into legislation is inflexibility to adapt to the market context and environment.

Other studies find that position limits reduce liquidity, increase execution costs, affect price volatility, and lead to a transfer of business from exchanges to OTC markets.[99] The impact on liquidity, execution costs and volatility stems from the fact that binding position limits reduce the volume of trading, from both speculators and hedgers (to the extent that limits on speculative trading activity

[96] Brennan, M. (1986), 'A theory of price limits in futures markets', *Journal of Financial Economics*, **16**, pp. 213–33. Circuit breakers temporarily halt trading when the price (or its variation) of an individual security or an index falls moves in excess of a pre-determined level.
[97] See, for example, Easterbrook, F. (1986), 'Monopoly, manipulation and the regulation of futures markets', *Journal of Business*, **69**, pp. 103–127; and Fiscel, D. and Ross, D. (1991), 'Should the law prohibit 'manipulation' in financial markets?', *Harvard Law Review*, **105**, pp. 503–553.
[98] ESMA (2020), 'Market impacts of circuit breakers – evidence from EU trading venues', ESMA Working Paper No. 1, 2020.
[99] Edwards, F. (1984), 'The clearing association in futures markets: guarantor and regulator', in R. Anderson (ed.), *The industrial organisation of futures markets*, Lexington; Pliska, S. and Shalen, C. (1991), 'The effects of regulations on trading activity and return volatility in futures markets', *Journal of Futures Markets*, **11**, pp. 135–151.

accommodate hedging demand, which is likely in the case of EUAs as speculators as a group take positions opposite to net hedging positions).

Some academic papers go further and find that position limits are counterproductive and detrimental for social welfare. For example, research by Gwilymn and Ebrahim (2013) presents a general equilibrium model within a setting of rational expectations, complete markets, and competition between economics agents. Under these conditions, the authors find that excessive speculation, with or without the intention to manipulate the futures market, is not worthwhile for the speculator, as it serves to enrich other agents in the economy at the expense of the speculator.[100] The restraints placed on speculators, in the form of position limits, are transmitted to hedgers through the demand and supply of futures, thereby inhibiting their freedom and ultimately impairing the social welfare of all agents in the economy.

[100] Gwilymn, R. and Ebrahim, M. (2013), 'Can position limits restrain 'rogue' trading?', *Journal of Banking & Finance*, **37**:3, pp. 824–836.

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