BANCA D'ITALIA

EUROSISTEMA

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THE USE OF DERIVATIVES ON CO_2-EMISSION ALLOWANCES IN ITALY

by Michele Leonardo Bianchi*, Maurizio Magnani* and Francesco Vercelli*

Abstract

In this paper, we study the Italian market for CO_2-emission allowances derivatives. The first part of the study illustrates the main characteristics of these instruments, the peculiarities of the market, and their use for risk hedging and investment purposes. The second part describes the development of CO_2-emission derivatives in Italy since 2021, exploring the EMIR database, which collects daily observations of transactions in derivatives. The evolution of the market is analysed in terms of notional values, its concentration and the interactions between the main players. Finally, we conduct a deep-dive analysis of the characteristics, price dynamics and term structure of CO_2-emission futures.

JEL Classification: G1, Q5.

Keywords: CO_2-emission allowances, CO_2-emission derivatives, granular data, EMIR.

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1. Introduction[1]

The European Union Emissions Trading Scheme (EU ETS) was launched in 2005 to reduce the emissions of greenhouse gases in the EU and it constitutes the second largest "carbon" market after the Chinese one. Companies operating in sectors characterized by high emissions of CO_2 are required to participate to this cap-and-trade scheme, which is based on emission permits, the so called European Union Allowances (EUAs): each EUA allows the holder to emit one ton of CO_2.[2] Every year EUAs are emitted, either by allocation or by auction, and companies must surrender enough allowances to fully account for their emissions in the previous year (see Section 2 for details). Once emitted, allowances can be freely traded in the secondary market. This approach incentivizes companies to efficiently reduce their carbon emissions, as the right to emit CO_2 becomes a tradable asset. For instance, power utilities in Europe have specific limits on the amount of CO_2 they can emit. Any production exceeding this limit must be offset by acquiring and surrendering emission allowances. Given the unpredictable nature of production and the fluctuations in EUAs prices, managers face emissions-related risks that they can mitigate by actively engaging in EUAs trading for appropriate risk management.

These permits are a new asset class (see also Medina and Pardo, 2022) with its distinctive features. The price determination of this asset and how to forecast its future price continue to attract increasing interest from researchers (see Chevallier, J., and Sévi, 2014). As observed by Trabelsi and Tiwari (2023), a better understanding of the price formation of emission allowances helps companies assess their business future risk, and policymakers to evaluate the achievement of the compliance with their environmental commitments.

In Europe the trading of permits is accompanied by an active secondary market, which is typical of every mandatory cap-and-trade system (see Carmona and Hinz, 2011). In this market, new financial instruments have developed: financial derivatives, especially futures, with EUAs as underlying. We refer to these derivatives alternatively as CO_2-emission or carbon or EUA derivatives. The study of these derivatives helps in the assessment of the underlying risk, in understanding the market expectation of future prices and market participants' perception of volatility. The interest by academics on these derivative products is not recent (see Daskalakis, 2009), however only recently

[1] The authors are grateful to Pierluigi Bologna, Alessio De Vincenzo, Silvia Fabiani, Alberto Felettigh, and Luigi Infante for their helpful comments and suggestions. The views expressed are those of the authors and do not necessarily reflect those of the Bank of Italy. The authors have no relevant financial or non-financial interests to disclose.
[2] Emission of CO_2 or similar greenhouse gas.

national competent authorities have started to analyse granular information on CO_2-emission derivatives (ESMA, 2022).

Since 2014, the European Market Infrastructure Regulation (EMIR) requires derivative counterparties in the EU to report their transactions to trade repositories (TRs). TRs data are confidential and only competent authorities may access this transaction-by-transaction data. In this work, we provide an overview of the market of CO_2-emission derivatives in Italy based on the EMIR data Banca d'Italia has access to. We explore the market characteristics, its growth trajectory, and significance in the realm of risk management and sustainable finance.

We find that the Italian CO_2-emission derivatives market, which represents nearly 14% of the Italian derivatives market on commodities[3] as of the end of June 2023, has rapidly grown in the last two years. Futures represent the majority of transactions in CO_2-emission derivatives, while the role of options is only marginal. These instruments are mostly sold by a few banks and bought by both non-financial Italian firms and non-resident units. The growing interest in these instruments as a way to manage carbon-related risks is confirmed by the increasing participation of non-financial firms, although still over 80 per cent of Italian compliance firms, namely those for which participation in the EU ETS scheme is mandatory, do not use EUAs derivatives.

The work is organized as follows. In Section 2 we briefly explain how the EU ETS works. After having described in Section 3 which are the main derivative contracts on permits and their main characteristics, in Section 4 we explore the EMIR database and provide an overview on the structure and on the main features of the Italian market.

2. CO_2-emission permits' system

2.1. *The EU emission trading scheme*

The EU emission trading scheme (EU ETS) is a cap-and-trade scheme for industrial installations and aircraft operators in the EU,[4] aimed at the reduction of CO_2 emissions. Every year the European Commission sets the overall EU-level cap for EUAs to be allocated, which correspond to an overall amount of CO_2 tons that can be emitted in the year. Once emitted, allowances are allocated for free to some operators or auctioned through a regulated process (primary market). Then, they can be freely traded in the secondary market. By 30th April firms have to surrender an amount

[3] EMIR classifies CO_2-emission permits among commodities; other derivatives on commodities actively traded on the Italian market refer mainly to energy and metals.
[4] 30 countries are participating in the ETS: the 27 EU Member States, Norway, Iceland and Lichtenstein.

of allowances equal to the number of tons of CO_2 emissions produced in their installations during the previous year. EUAs do not have an ending date so firms can carry over EUAs from one year to the other.

Companies and installations operating in sectors characterized by high emissions of CO_2, like those involved in the production of electricity and aircraft operators, are obliged to participate to the ETS system.[5] These companies are referred to as *compliance firms*. Nearly 10,000 installations participate to the EU ETS.

The scheme started in 2005, it has evolved in four different phases. In the first phase all allowances were allocated for free, as firm-specific endowments at the beginning of the year. An allocation scheme based on auctions was introduced during the second implementation phase (2008-2012), although 90 per cent of the permits was still freely allocated. This percentage decreased to 40 per cent during the third implementation phase, which started in 2013. The free allocation mainly related to sectors at risk of carbon leakage, i.e. of outsourcing activities outside the EU in order to avoid environmental restrictions (Dal Savio et al., 2022). The other firms received an amount of EUAs free of charge equal to the carbon emissions of the most efficient firms operating in the same sector. In this way, less efficient firms had stronger incentives to de-carbonise since they had to buy more EUAs to fulfil their obligations.

During the second and the third phases, supply of allowances turned out to exceed demand and consequently prices remained extremely low, thus providing little incentive to cut emissions. With the fourth phase (2021-2030), the share of allowances allocated for free is expected to be reduced progressively towards the zero-target at the end of the period, with few exceptions like for sectors at risk of carbon leakage.[6]

The EU commission assigns to each Member State the amount of EUAs that can be allocated for free among its compliance firms and the amount they can buy through auctions. Each Member State chooses the allocation of the free-of-charge EUAs across its national firms, verifies the effective emissions through inspections and decides the setting and the enforcement of sanctions. In Italy the authority appointed for these activities is the ETS committee, hosted at the Ministry of the Environment (*Ministero dell'Ambiente e della Sicurezza Energetica*).[7] The "*Gestore dei Servizi Energetici*" (GSE) manages the auction system and there are entities appointed by Accredia ("*Ente*

[5] Some exceptions linked to size and capacity thresholds apply (Bufano et al., 2022).
[6] In particular, in 2020 for these sectors a new mechanism was introduced, the carbon Border Adjustment Mechanism (CBAM), which uses tariffs in order to equalize the carbon price between domestically-produced goods and imported goods. See https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en.
[7] This has been set in the Legislative Decree 9 June 2020, no. 47, to implement the EU directive 2018/410 of the European Parliament and of the Council of 14 March 2018.

Italiano di Accreditamento") to verify emissions. Every year the emission reports, prepared by compliance firms and containing information on the amount of emissions in the previous year, have to be examined by accredited verifiers by 31st March. Then, firms have to surrender a number of allowances equivalent to the verified amount of emissions by 30th April. For each ton of emissions for which no allowance is surrendered in due time, there is a sanction of around 100 euro per ton of CO_2,[8] on top of the obligation to surrender the missing EUAs, which for example can be bought on the secondary market.

All EUAs transactions must be recorded in the Union Registry, that serves to guarantee accurate accounting for all allowances issued in the EU. Therefore, whoever needs to obtain or transfer "physical" EUAs is required to hold an account at the Registry. There are two major types of accounts: "operator holding accounts" are used to fulfil compliance obligations, while "trading accounts" have more flexible transfer rules and are used both by compliance and non-compliance entities. As shown in a recent report by the European Securities and Markets Authority (ESMA),[9] in January 2022 nearly 40 per cent of EUAs were held by compliance firms in operator holding accounts; concerning the residual 60 per cent that was held in trading accounts, almost 20 per cent referred to compliance firms and 40 per cent to non-compliance entities.

2.2. *The auctions*

Auctions take place throughout the year on the European *definitive common auction platform* (CAP3), managed by the European Energy Exchange AG (EEX) in Germany.[10] The participation to auctions is not restricted to compliance firms, but it is also extended to other entities, like banks and investment funds. As reported by ESMA, in 2021 only 48 participants ever participated to an auction, with an average number of participants per auction around 18. Among the participants, 34 were non-financials entities and the largest three among them obtained almost half of the overall auctioned amounts.[11] ESMA argues that the small number of entities participating to the auctions may stem from the costs of participation, as opposed to relying exclusively on services provided by investment firms in secondary markets.

[8] Since 2012, the base sanction of 100 euro is annually updated according to the harmonized index of consumer prices.
[9] See https://www.esma.europa.eu/document/final-report-emission-allowances-and-associated-derivatives. In 2021 ESMA was asked by the European Commission to closely assess the trading of EUAs in order to examine patterns of trading behaviors and the potential need for targeted actions. Thus, ESMA published a report on March 2022 (ESMA, 2022), containing a comprehensive view of EU carbon markets.
[10] EEX has been awarded the role as the common auction platform to auction allowances on behalf of EU Member States and the other ETS participant States.
[11] Between June 2020 and December 2021 the total market value actioned was 41.8 billion euro.

Each participant privately submits bids, declaring the number of EUAs to buy (at least 500 units) and the reservation price. All bid prices are sorted in descending order and the clearing price is the price at which supply matches total demand: all bids are fulfilled and the EUAs are sold at the clearing price. The auction is null if supply is larger than overall demand, for any price. The auction is cancelled when the clearing price would be significantly below the price on the secondary market,[12] which would allow market participants to benefit from arbitrage between the primary and secondary markets.

2.3. *The secondary market*

Transactions on secondary markets generally take place on regulated trading venues. In Europe the most important platform is ICE Endex, in the Netherlands, which offers trading on EUAs both with spot contracts and with derivatives.[13] In addition to the negotiation on trading venues, bilateral transactions can also take place over-the-counter (OTC).

Looking at EUAs prices, they remained extremely low until 2017, below 10 euro, probably due the oversupply of allowances in the market (ZEW/KfW CO_2 Panel, 2015). They increased rapidly at the beginning of 2018 (Figure 1), reaching 21 euro per ton of CO_2 in August. Then, they fluctuated around 20-30 euro until the Covid-19 pandemic. After an initial reduction of the EUAs price induced by the COVID-19 crisis, the price started to increase rapidly at the beginning of November 2020, boosted by the announcement of more stringent climate policy objectives by the EU. In May 2021 the price exceeded 50 euro and at the end of September stood around 60 euro. Then, the EUAs price skyrocketed to almost 90 euro in mid-December and reached 96 euro in February 2022. According to ESMA (2022), this increase mirrored the spike in gas prices that occurred in the winter, before the war in Ukraine broke out, which increased the relative attractiveness of coal as a substitute for gas in electricity production, raising the demand for EUAs since coal is more CO_2-intensive than gas.

According to ARERA[14], the Italian authority in charge of regulatory and supervisory activities in the sectors of electricity and natural gas, the pass-through of rising EUAs prices on wholesale electricity prices became evident: the sharp increase of wholesale electricity prices in 2021 reflected also the rising costs of CO_2 permits.

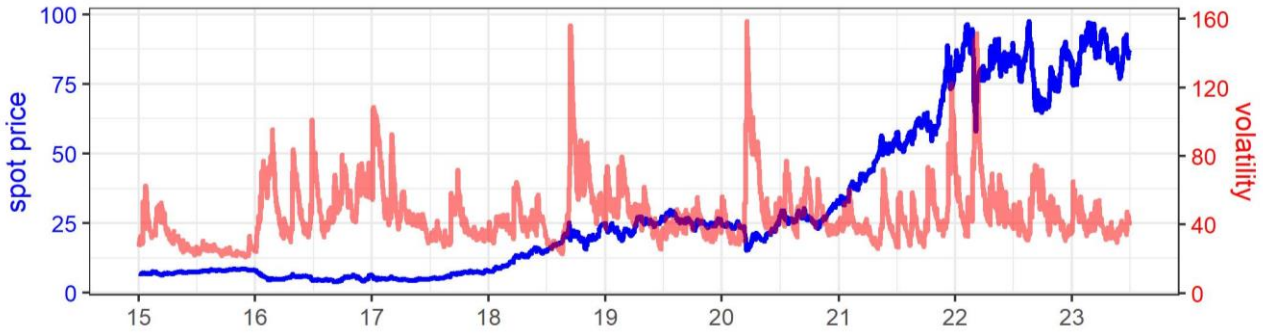
In March 2022 the price plummeted, reaching a temporary minimum below 60 euro, driven by several reasons mostly related to the Ukrainian war. The expectations of an economic slowdown

[12] Article 7 (6) of Regulation 1031/2010.
[13] Other European platforms exist but have a marginal role: the European Energy Exchange, in Germany, and NASDAQ OMX Commodities Europe in Norway (Oslo).
[14] See on the ARERA website (https://www.arera.it/it/relaz_ann/21/21.htm).

induced by the war and gas supply disruptions suddenly decreased the demand for EUAs. ESMA (2022) argues that the large sales of EUAs observed in that period may also be linked to the need of closing positions in EUAs to meet margin calls for gas and oil contracts. Moreover, as outlined by Bufano et al. (2022), there was the expectation that the shortage of gas due to the war would have postponed the green transition. Since March 2022 EUAs prices have shown large variations, reaching the maximum value of 98 euro in August and dropping to around 65 euro one month later. At the end of June 2023 the price stood at 86 euro.

Given that in the fourth phase of the EU ETS system the EUAs supply is cut by 2.2 per cent per year and that the EU Commission aims to further step up the pace of reduction, some private operators expect EUA prices to rise, up to around 130-150 euro in 2030.[15] A mechanism is also at work to support prices, so that returning to the low levels that characterized the first phases of the ETS is very unlikely. Indeed, the Market Stability Reserve (MSR), established in 2015 and operational since 2019, is aimed at avoiding cases of excess supply: the mechanism automatically reduces the auction volumes when the total number of outstanding permits exceeds a certain threshold.[16]

Figure 1 – EUA spot price and volatility
(daily data; 2015-2023; euro and per cent)



Source: International Carbon Action Partnership (ICAP) and Banca d'Italia estimates.
We report EUA spot prices (lhs, blue line) and the corresponding estimated GARCH(1,1) annualized volatility (rhs, red line) between January 2015 and June 2023.

2.4. *The counterparties*

The relationships among the participants to the EUAs market (compliance firms, banks and other financial intermediaries) have been studied in several papers, although the period of analysis usually does not cover the most recent years (Wallner et al., 2014; Betz and Schmidt, 2015; Cludius and Betz, 2020; Jaraitė-Kažukauskė and Kažukauskas, 2015). A relevant insight is that large compliance firms are generally more involved in the EUAs market and have a higher probability to

[15] Bloomberg Intelligence – Technical Outlook: Carbon Emissions 21st Century Bull – 15.03.2021.
[16] See https://emissions-euets.com/carbon-market-glossary/957-market-stability-reserve.

have relationships with both banks and other financial intermediaries than smaller ones (Cludius and Betz, 2020). Trading on allowances is relevant for companies whose initial allocation of EUAs is lower than their carbon emissions, and this always happens for companies in the electricity sector. As reported by Wallner (2014), large utilities perform an active hedging strategy with daily trades using EUAs-related derivatives. Smaller firms, instead, are more likely to trade only on the spot market, mainly following simple trading strategies (Wallner, 2014; Cludius and Betz, 2020).

The presence of large utilities in the EUAs market, which sometimes act as intermediaries for small compliance firms, reflects both their large need of permits and their experience in trading, accrued for instance on commodities like oil and gas (Wallner, 2014). Instead, firms in other sectors are less involved in the market. Indeed, in the first phases of the EU ETS they were able to cover their emission requirements through the EUAs allocated for free and often stored the EUAs that exceeded their emissions, anticipating their expected increasing demand in the future (ZEW/KfW CO_2 Panel, 2014).

Banks have always played an important role in the EUAs market. They predominantly operate on behalf of compliance companies, raising fees as providers of management or technical services (e.g., brokerage), as observed by Cludius and Betz (2020). Indeed, for small and medium-size compliance firms is often more expensive to trade EUAs by themselves than through banks, which charge variable fees depending on the volume of trading (Wallner et al., 2014). Some banks also act as market makers, with a constant presence at auctions (Betz and Schmidt, 2015). Purely speculative activity on EUAs, instead, is not expected to be relevant for banks (Wallner et al., 2014; Cludius et al., 2022). Nevertheless, the speculative activities of some participants are gaining an increasing attention by policymakers, who are working on more stringent regulatory frameworks[17] in order to ensure the price stability of the EUAs markets.[18]

Providing risk management services through the development of derivative products is another important service offered by banks to compliance companies (Wallner et al., 2014). For example, banks can transform standardized future contracts in more customized forward contracts (Cludius and Betz, 2020). Hedging is particularly important for utilities, because they often provide long-term supply contracts, with the commitment to deliver a certain amount of power at a given price at a predetermined maturity date (Wallner, 2014). Therefore, since they face the risk of rising costs of emission permits, derivatives can help their hedging needs. For example, banks can buy

[17] See https://www.europarl.europa.eu/RegData/etudes/STUD/2022/740052/IPOL_STU(2022)740052_EN.pdf.

[18] The introduction of a price corridor is under assessment, which would be the most direct and effective measure for controlling the price path and would prompt many speculators to leave the market as there would be little uncertainty left to speculate on. However, designing a price corridor entails the risk of setting it too wide or too narrow, thus impeding the achievement of climate goals.

EUAs on the spot market and sell forwards or futures to electricity companies (Cludius and Betz, 2020). Thanks to derivative contracts, compliance firms can cover future CO_2-emissions, pre-determining the cost associated with the purchase of the needed EUAs on the spot market.

3. CO_2-emission derivatives

As it happened for other financial instruments, CO_2-emission derivatives have started to be traded along with the development of EUAs market. As assessed by the report published in 2021 by the International Swaps and Derivatives Association (ISDA),[19] firms use CO_2-emission derivatives for different purposes: companies subject to carbon compliance programs use derivatives to manage risks associated with ETS obligations; banks and other financial players sell futures or forwards to compliance entities; asset managers can use carbon derivatives to develop portfolios that meet the growing interest to invest in companies that are actively decarbonizing. In addition, derivatives markets play a major role in enhancing transparency through the provision of forward information on pricing of the underlying assets, which provides helpful signals to policy-makers.

Commonly traded types of carbon derivatives in Europe are futures, forwards, options and swaps. All exchange-traded derivatives[20] have standardised features: the contract size (lots of 1,000 EUAs), the underlying currency (euro), the tick value (10,000 euro per contract), the expiration date (last Monday of the contract month), the maturity (mostly short-term).

The most traded futures on carbon emissions[21] have maturity between 6 months and one year and expire in December. Since compliance entities are required to surrender allowances by 30th April, futures expiring in March are also relevant. Futures with maturity below 6 months are mostly traded by financial companies. As observed by ESMA (2022) trading on futures with maturity over one year generally takes place in the last part of the year.

Based on data by the clearing house ICE,[22] part of the positions in futures is rolled over from one year to the next one. ESMA (2022) argues that, since power companies have long-term production plans, they build their hedging strategies over several years. Every December, they use some contracts

[19] See https://www.isda.org/a/soigE/Role-of-Derivatives-in-Carbon-Markets.pdf.
[20] Exchange-traded derivatives (ETDs) on EUAs mainly involve the following central clearing counterparties (CCPs): European Commodity Clearing (ECC AG) in Germany, ICE Clear Europe Ltd. in the UK, and Nasdaq Clearing in Sweden.
[21] In a futures contract the counterparties agree to trade EUAs at a certain price on a certain date in the future. The contract does not necessarily result in physical delivery, as it could also be satisfied by a payment based on the current market price at maturity (i.e., cash delivery). Since futures contracts are exchange-traded they follow standardized and regulated trading rules, as explained above.
[22] See https://www.theice.com/marketdata/reports/159.

to satisfy their need of EUAs for covering previous year emissions, and they roll over the remaining contracts.

Moving to over-the-counter contracts (OTC), forwards[23] are particularly useful for hedging needs of large power companies. Bearing the risk of rising costs of both carbon emission permits and fuel, they can better address the different sources of risk through OTC derivatives, which, unlike exchange-traded derivatives, have terms and notional amounts tailored to customer's needs.

Options[24] have become remarkably important in the most recent period in the European market. They allow firms to cover from the risk of adverse price movements as the premium paid constitutes the maximum loss for the buyer. Usually, the underlying of options on EUAs is the December futures contract of the current year. The expiry dates are three days before the expiry of outstanding futures. As described by the ESMA report, in the last 2 years there has been a clear trading pattern for options, with a strike price close the underlying price (i.e. at the money).[25] These options are, as usual, the most traded and liquid. Moreover, ESMA observed that the traded volumes have become more distributed across various strike prices. For call options, also a large amount of trading activity on out of the money options (i.e. when the strike price is greater than the current price of the underlying) has been observed.

Swaps[26] on EUAs are mainly used by power-generating companies[27] in order to manage the market risk related to EUAs by setting the price of the underlying in advance. In most of the cases, the underlying of these contracts is the daily closing price of the December future on EUAs published during the calculation period defined in the contract.

[23] A forward contract is a "customized" futures contract, traded over the counter (OTC). Being a bilateral contract, if it is not collateralized, it triggers the risk that one of the two parties will not honour its contractual commitments. Before signing a forward contract, each party typically assesses the risk that the other party will not be able to fulfil its contractual commitment. Therefore, such arrangements are more suitable for players with more developed risk management strategies, which are able to assess the credit risk of the counterparty. See Carbon Offset Guide Contract Terms: www.offsetguide.org/understanding-carbon-offsets/how-to-acquire-carbon-offset-credits/buying-offsets/contract-terms/.

[24] The holder of an option contract has the opportunity to either buy (a call option) or sell (a put option) EAUs, or futures contracts on EAUs, at a price agreed in the contract (strike price). The main difference from a futures contract is that the option does not require the exchange of the underlying EUAs to happen on the expiration date of the underlying. A fee (premium) is paid upfront for this flexibility.

[25] To investigate distinct option patterns, ESMA used ancillary information reported in EMIR.

[26] Swaps are non-standardized exchanges of EUAs or cash flows, traded in OTC markets. The buyer and the seller agree to exchange future payments periodically: the buyer pays a fixed price while the seller pays a variable price which depend on the market price of the underlying.

[27] See for example: https://globaltrading.enel.com/financial-products/swap-co2.

4. The derivatives markets in Italy

In the following subsections, we first describe EMIR data that Banca d'Italia has access to. Then, we exploit the database to analyse the patterns of EUA derivatives involving Italian counterparties. Whenever possible, we provide some comparisons with the European market based on the report by ESMA (2022). However, the information provided in the report does not always allow recovering the exact definitions and procedures we have adopted. While ESMA tries to identify only client reports, by de-chaining multiple reports,[28] we consider all transactions including trades between final clients, clearing members acting as intermediaries and central clearing counterparties (CCP). This is motivated by the fact that we want to visualize the entire network of these derivatives, also to understand who are the intermediaries operating in this market.

4.1. EMIR data

The European Market Infrastructure Regulation (EMIR), adopted in 2012, requires all EU derivative counterparties to report their transactions to trade repositories (TRs). The TRs then make this information available to relevant regulatory authorities, such as central banks, financial supervisory authorities, and ESMA. This obligation not only includes the execution phase of both OTC and exchange-traded transactions but also post-trade activities such as clearing or compression. This combination of different views on this sophisticated and heterogeneous market makes EMIR data a unique source of information.

The information collected in EMIR can be categorized as follows (see Bianchi et al., 2025, for more details):

(1) trade details: EMIR requires the reporting of detailed information related to derivative transactions, including trade identifiers, dates and times of trade execution, product type, underlying assets, notional amounts, contract maturity dates, contract characteristics;

(2) counterparty information: EMIR mandates the reporting of information about the counterparties involved in derivative transactions, including the legal entity identifier (LEI) and their roles in the transaction;

(3) valuation and margin data: market participants are required to report the valuation of derivative contracts and of the related margins on a daily basis. However, concerning futures,

[28] In ESMA (2022) all the trades between clearing members and CCPs have been removed, keeping only the original trades between clients and clearing members.

the contract value reported in EMIR does not represent the fair value of the position (i.e. the risk exposure) but, generally, it coincides with the notional amount.

ESMA and the European Systemic Risk Board (ESRB) have access to the full EU-wide dataset. Banca d'Italia has full access to those transactions where one of the counterparties is an Italian resident or where the underlying asset is issued by an Italian entity.[29]

The reports are of two types: (1) trade activity reports, to which we refer to as *activities*, containing all reports on transactions; (2) trade state reports, to which we refer to as *states*, containing all pending trades at the end of the reporting day, i.e. end-of-day stocks. While states are considered for quantifying the notional outstanding, activities are explored to find daily prices and volumes.

We identify the EUAs derivatives according to the EMIR classification of the underlying assets (the asset class of these contracts is *commodity* and *emission allowances*). In this paper, we aggregate information at the group level since trading and risk management activities are likely to be conducted at a consolidated level, possibly as part of parent company duties or by subsidiaries specialized in trading activities. Therefore, transactions involving foreign subsidiaries of an Italian group are included. Vice versa, domestic firms owned by foreign groups are excluded, since we have not access to all transactions involving EU counterparties.[30] In the following, the expression "Italian counterparties" refers to Italian groups instead of Italian entities.

4.2. The Italian market

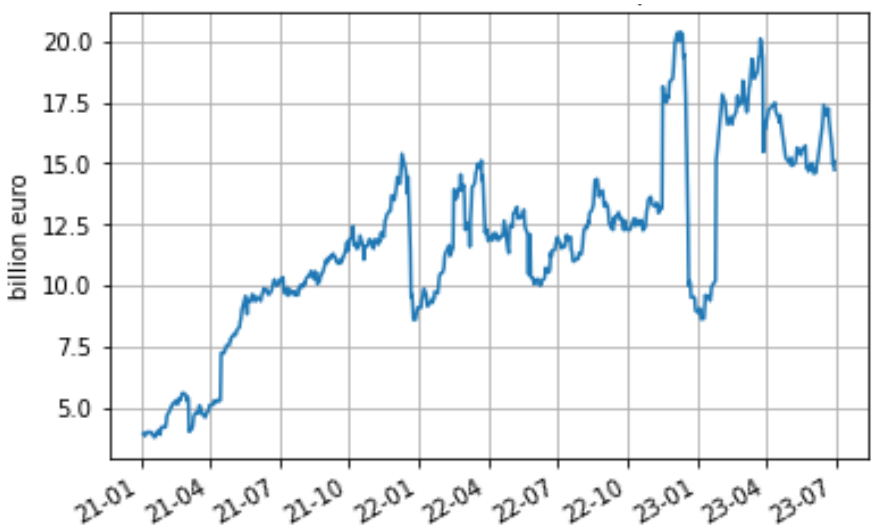
Analysing EMIR data we found that, as of the end of June 2023, the notional of derivatives on EUAs traded by Italian counterparties was equal to 15 billion euro, which accounts for nearly 14 per cent of the commodity derivatives involving at least one Italian counterparty. We can assess the size of the market also compared to the potential hedging needs of Italian compliance firms. Since in 2022 they had to surrender about 220 million of EUAs, net of those allocated for free, and the average spot price in 2022 for one EUA was almost 81 euro, the overall market value of the allowances to be surrendered was nearly 18 billion euro. This is a rough estimate of the maximum value to be hedged by Italian compliance firms; however, as we will show below, a large fraction of the overall Italian market does not concern CO_2 derivatives bought by compliance firms.

[29] Beyond this general rule, Regulation (EU) 2019/361 grants Banca d'Italia access to a broader perimeter. For example, Banca d'Italia should have access to derivatives where the reference entity of the derivative is established within the euro area and falls under the supervisory responsibilities and mandates of Banca d'Italia. The implementation of the regulation was not homogeneous among different TRs and, for this reason, until the end of February 2024 some information was missing.

[30] As of the end of February 2024, Banca d'Italia started receiving all the information it is entitled to access, including all transactions involving euro area counterparties.

In Figures from 2 to 5, we describe the outstanding notional amount of derivative contracts in which at least one counterparty is Italian. Contract types, counterparty sectors and countries are analysed.

Figure 2 – Notional outstanding amounts of CO_2-emission derivatives in which at least one counterparty is Italian.
(daily data; 2021-2023; billion euro)

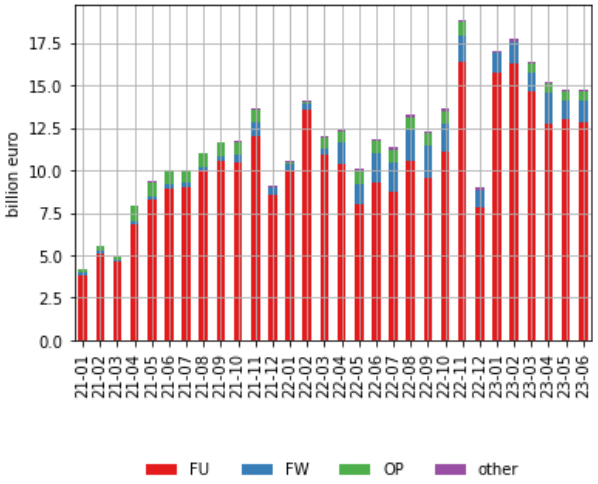


Source: EMIR data available to Banca d'Italia.

As shown in Figure 2, the notional amount of EUA derivatives held by Italian entities has increased in the recent period. Between January 2021 and June 2023, the stock more than tripled, from around 4 to 15 billion euro. The share of CO_2-emission derivatives to overall commodity derivatives rose from 8 to 14 per cent, with a peak of 18 per cent in March 2023. The drops observed in December are seasonal patterns, mostly due to the expiration date of futures contracts, as explained in Section 4.3. The dynamics mechanically reflects both the number of contracts[31] and the EUAs spot prices used to compute the market value of the notional amounts, as reported in Figure 1. The rapid rise in 2021 mimicked the increase of EUAs prices, following the announcement of more stringent climate policy objectives, but it was also due to the increase in the number of contracts. Then, in 2022 the notional amount fluctuated and reached the historical peak of around 20 billion euro at the beginning of December. In the first half of 2023, the notional amount decreased to nearly 15 billion euro, still a much higher value than in the two previous years. The rise of the EUA market was observed also at the European level (ESMA, 2022): between 2020 and 2021 in Europe the notional amounts traded per month rose from 25 to 94 billion euro and trades doubled from 200,000 to 400,000.

[31] This will also be shown in Section 4.3, which is entirely devoted to futures contracts.

Figure 3 – Notional outstanding amounts by contract type.
(end-of-month data; 2021-2023; billion euro)



Source: EMIR data available to Banca d'Italia.
Contract types: forwards (FW), futures (FU), options (OP), and other.

At the end of June 2023, futures represented the largest fraction of the overall notional amount (12.8 billion euro over a total of 15, above 85 per cent), followed by forwards (1.4 billion euro), and options (0.5 billion euro).[32] Although futures have always maintained a prominent role (red bars in Figure 3), forwards have been increasingly important since 2022 (blue bars). Options instead remained marginal, in contrast with the evidence on the overall European market, where they exceeded one fourth of the notional amounts in 2021, as observed by ESMA (2022).

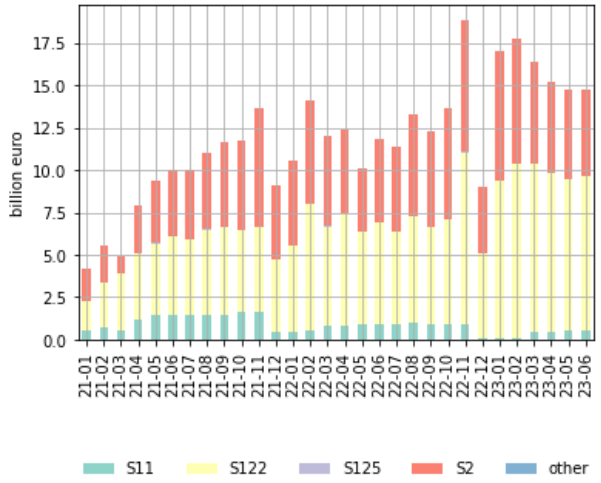
Figure 4 distinguishes the notional amount of derivatives by sector of the seller (Panel a) and sector of the buyer (Panel b).[33] More than half of notional amounts are sold by resident banks (Figure 4.a); non-resident entities also play a relevant role, which increased in the period of analysis. As expected, resident non-financial corporations buy a significant fraction of derivatives (Figure 4.b), around 20 per cent, probably to hedge risks associated with the obligation to participate in the EUAs market and the uncertainty about the amount of the EUAs to be surrendered. More than half of the purchased CO_2 derivatives concerns non-resident entities (mainly non-financial corporations). According to ESMA (2022), in the European market nearly 40 per cent of entities dealing with EUA derivatives are compliance companies, followed by other non-financial companies, mutual funds, investment firms and banks. On average, non-financial corporations display larger notional amounts

[32] The remaining derivatives were swap and other derivatives. Futures and options are exchange traded and cleared, while all other derivatives are OTC and not cleared.
[33] EMIR data are here aggregated at the group level, so the sector of classification refers to the holding company. According to National accounts rules, holding companies of non-financial firms (S11) are classified in S11 if they undertake some management activities and their subsidiaries are mostly involved in non-financial operations (they are usually defined as head offices).

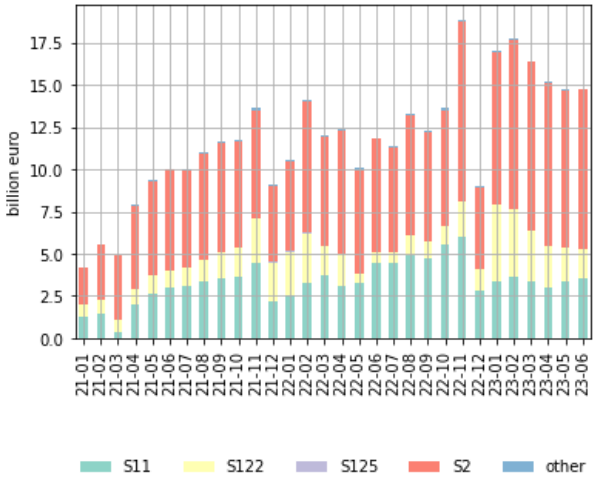
and a lower number of trades with respect to financial institutions, which trade more frequently. In December 2021, around 60 per cent of notional amounts in the European market were related to hedging operations.

Figure 4 – Notional outstanding amounts by sector of the seller and of the buyer.
(end-of-month data; 2021-2023; billion euro)

(a) Sector of the seller



(b) Sector of the buyer



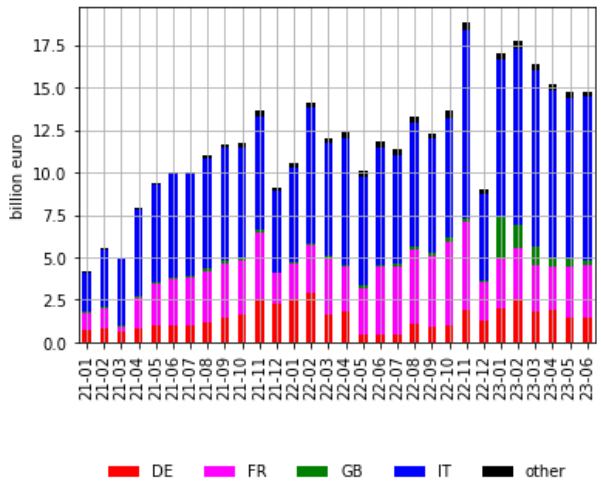
Source: EMIR data available to Banca d'Italia.

Transactions involving at least one Italian counterparty. S11: Italian non-financial corporations; S122: Italian banks; S125: Italian other financial intermediaries; S2: non-resident entities.

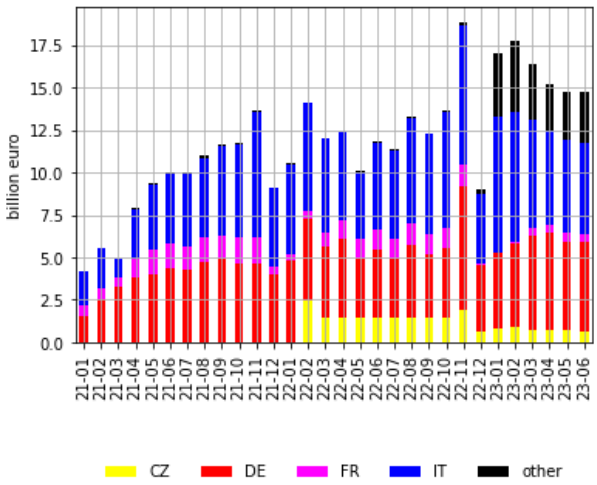
As shown in Figure 5, which disentangles notional amounts by country of the seller (buyer), most of non-resident seller counterparties are French or German. Instead, Germany represents by far the largest fraction of non-resident buyers. In the European market, the most active counterparties are German and Dutch (ESMA, 2022).

Figure 5 – Notional outstanding by country of the seller and of the buyer.

(a) Country of the seller



(b) Country of the buyer



Source: EMIR data available to Banca d'Italia.

Transactions involving at least one Italian counterparty. S11: Italian non-financial corporations; S122: Italian banks; S125: Italian other financial intermediaries; S2: non-resident entities.

More in detail, focusing on the Italian counterparties, at the end of June 2023 Italian non-financial corporations had a notional exposure of nearly 4 billion euro, mainly in futures contracts. As shown in Table 1, non-financial companies generally have a long exposure in the futures and forward EUA contracts. These firms are mostly involved in the combustion of fuels and the refinement of mineral oil. The exposure of the Italian financial sector, mainly referring to banks, was higher than that of non-financial firms, standing at around 11 billion euro in June 2023. In contrast with non-financial corporations, banks mostly present short positions and engage in forwards besides futures.

Table 1 – Italian counterparties: notional amounts by contract type.

(million euro)

Date	Sector	Futures			Forwards			Total		
		Total	Buy	Sell	Total	Buy	Sell	Total	Buy	Sell
2021-06-30	S11	3,459	2,724	734	214	69	146	4,452	2,967	1,485
	S12	5,597	1,010	4,587	4	-	3	5,740	1,125	4,616
	Total	9,056	3,734	5,321	218	69	149	10,192	4,092	6,101
2021-12-31	S11	2,137	1,999	138	405	82	323	2,635	2,146	490
	S12	6,599	2,383	4,216	4	-	3	6,705	2,434	4,271
	Total	8,736	4,382	4,354	409	82	326	9,340	4,580	4,761
2022-06-30	S11	4,275	4,090	186	404	103	301	5,422	4,485	937
	S12	5,133	556	4,578	1,311	1	1,310	6,627	615	6,012
	Total	9,408	4,646	4,764	1,715	104	1,611	12,049	5,100	6,949
2022-12-29	S11	2,749	2,693	56	64	56	9	2,878	2,802	76
	S12	5,331	1,326	4,005	931	7	924	6,386	1,364	5,022
	Total	8,080	4,019	4,061	995	63	933	9,264	4,166	5,098
2023-06-29	S11	3,269	3,168	101	248	240	9	4,083	3,575	509
	S12	9,564	1,641	7,923	1,221	117	1,104	10,902	1,787	9,115
	Total	12,833	4,809	8,024	1,469	357	1,113	14,985	5,362	9,624

Source: EMIR data available to Banca d'Italia.
Derivatives other than futures and forwards are not reported but are included in the total notional amount. Transactions between two Italian counterparties are reported twice: once in column "Buy" and once in column "Sell". The data are aggregated on a consolidated basis. The derivatives of some non-Italian subsidiaries may be not reported and this may affect the estimates, especially those related to the largest companies. S11: Italian non-financial corporations; S12: Italian financial intermediaries.

Analysing data on all Italian counterparties at the group level, in June 2023 only two counterparties, out of 40 in total, had notional exposure above 1 billion euro (19 above 5 million of euro). A small number of Italian banks, who likely act as intermediaries, are participating in the

market, even though just one is concentrating almost all the transactions.[34] For each bank the stock of emission derivatives constitutes however less than 0.5 per cent of the overall gross notional of their derivatives portfolio and is small in terms of total assets.

Figure 6 – Network of notional exposures.

(a) June 30, 2022

(b) June 30, 2023

Source: EMIR data available at the Banca d'Italia.
Data are reported at the individual level and refer to transactions where at least one counterparty is an Italian entity or a foreign subsidiary of an Italian group.

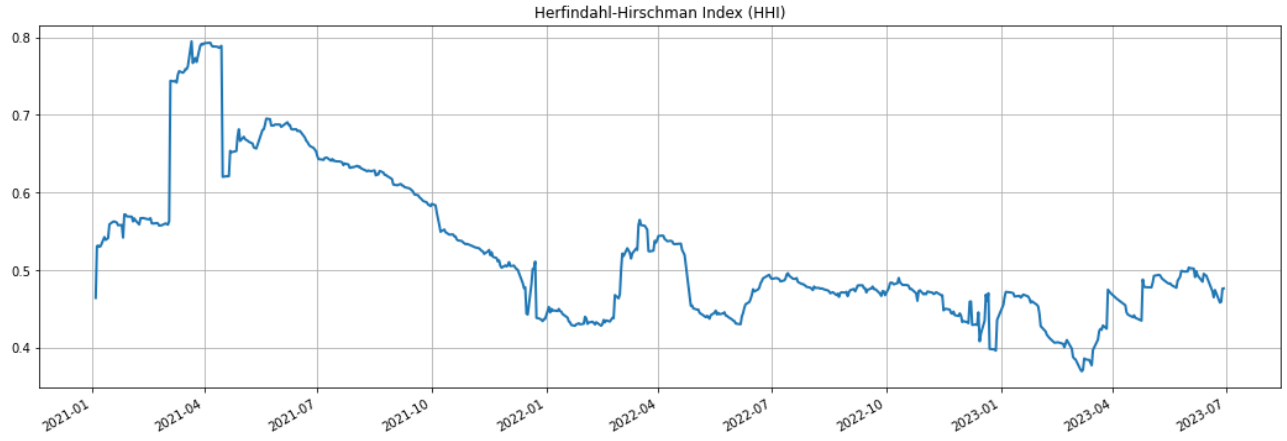
[34] Market liquidity is assured since most of transactions refer to futures, which are exchange-traded in platforms where major European entities act as counterparties.

Figure 6 shows the network of all entities (nodes) with a CO_2-derivative exposure on June 30, 2022 and on June 29, 2023. The size and the colour of each node are proportional to the overall exposure of the entity while the thickness and the colour of each edge are proportional to the overall notional amounts of the contracts between the two nodes. Unlike the rest of the work where data are aggregated at group level, in Figure 6 data are reported at the individual level and refer to transactions where at least one counterparty is an Italian entity or a foreign subsidiary of an Italian group. This allows us to have a broader view of the network.

The network structure does not vary over time: on both dates considered there are two main clusters, both with center at a bank. The two clusters are connected with each other through a few edges. The first cluster displays a large number of direct connections with several foreign non-financial corporations. The second cluster, instead, shows direct relationships between a bank and a few Italian non-financial corporations with a remarkable activity in CO_2 derivatives. Finally, there is a third minor cluster, centered at a third bank and connected with several Italian non-financial corporations, characterized by limited activity in EUAs derivatives.

We now return to group-level data. Figure 7 displays the Herfindahl-Hirschman index computed on the notional amounts of CO_2-emission derivatives transactions by Italian non-financial corporations. There is an overall downward trend since April 2021, suggesting that these derivatives have become more widespread among non-financial corporations.

Figure 7 – Concentration of CO_2-emission derivatives among non-financial corporations.



Source: EMIR data available to Banca d'Italia.
Transactions with at least one Italian entity. The Herfindahl-Hirschman index is computed on the basis of the notional amounts of transactions of Italian non-financial corporations.

The European Union transaction log (EUTL) reports the list of Italian firms that are obliged to participate to the ETS system and the number of EUAs that are allocated for free and those that have been surrendered. We identify compliance firms that do not use EUAs derivatives as those ones

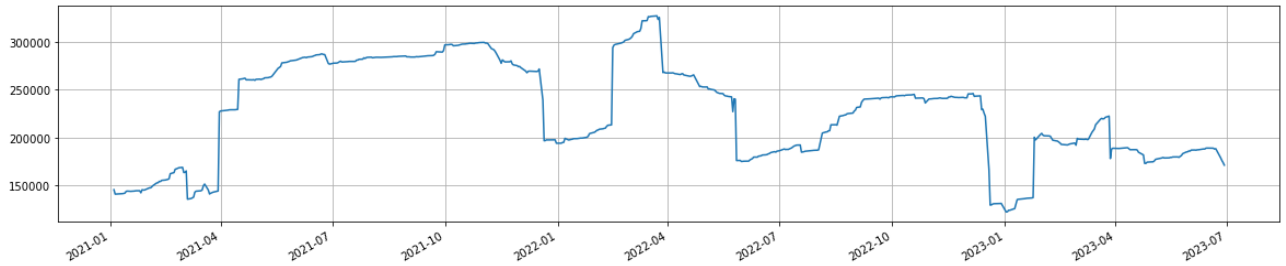
without positions in emission derivatives in the EMIR database, either directly or through other firms of the same group. In 2021 and 2022, over 80 per cent of Italian compliance firms did not use EUAs derivatives. At the same time, more than 75 per cent of EUAs that were surrendered in 2021 and 2022, net of those allocated for free, referred to companies that used emission derivatives. That means that the largest firms already participate to the emission derivatives market. At the same time, as outlined at the beginning of this section, a rough approximation of the maximum amount to be hedged is close to 18 billion euro, whereas according to Table 1 the notional amounts bought by non-financial firms, which proxy compliance firms, is generally below 5 billion euro. These two pieces of information suggest that the market of emission derivatives in Italy has room for enlarging in the future.

4.3. Futures contracts

This section is focused on futures contracts,[35] which represent the most traded kind of EUA derivatives, and is based on EMIR data enriched with the information collected by ESMA in the Financial Instruments Reference Database System (FIRDS).[36]

Figure 8 shows that the outstanding quantities of futures contracts, i.e. the number of futures, held by Italian counterparties has decreased since April 2022, although the notional value of these derivatives has increased due to the rise in prices, as shown in Figure 1. A seasonal pattern is observed, with a drop in the quantities before the end of the year.

Figure 8 – Future quantities over time.
(daily data; 2021-2023)



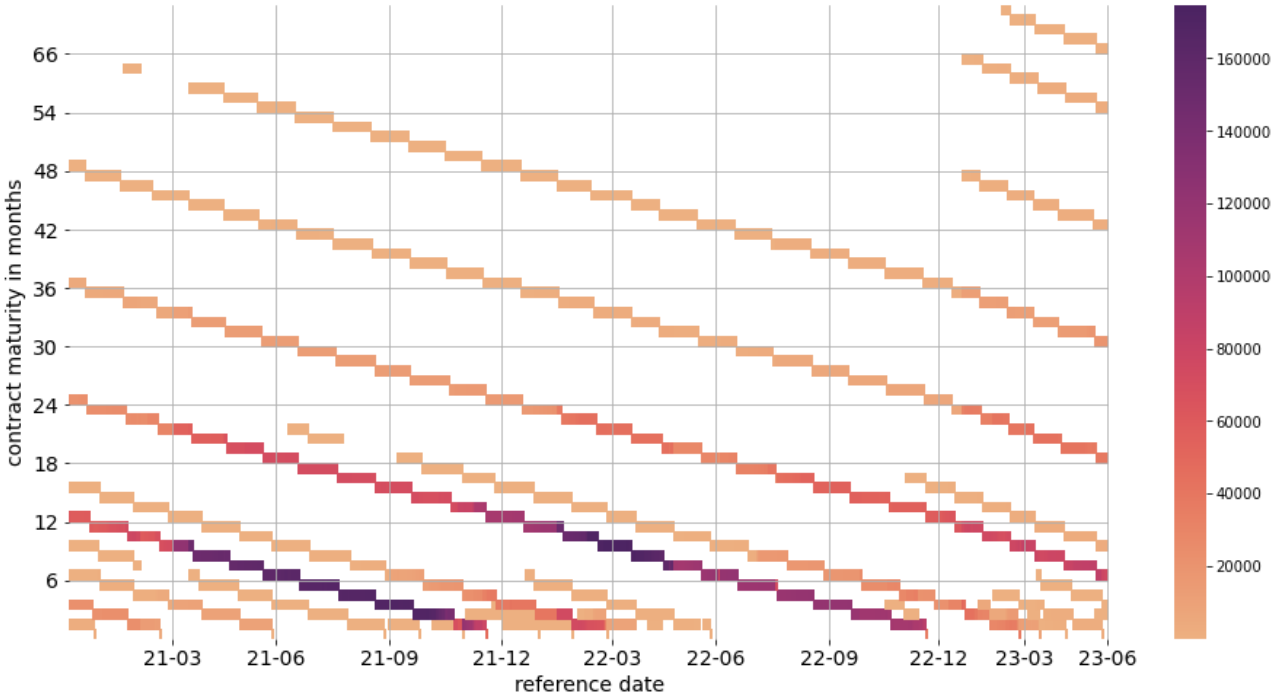
Source: EMIR data available to Banca d'Italia.
For each trading day we report the quantity of outstanding futures.

Figure 9 shows the dynamics of the outstanding quantities over time and across maturities by means of a heatmap: for each trading day on the horizontal axis and for each contract maturity on the

[35] More details on futures can be found in Section 3.
[36] The FIRDS system was launched in July 2017 with the objective to support the requirements for reference data collection and publication introduced by the Market Abuse Regulation (MAR) and the Markets in Financial Instruments Regulation (MiFIR). It is published by the ESMA and lists meta-information on all financial instruments included in the scope of the above mentioned regulations.

vertical axis, the darker the cell the higher the outstanding quantities. Each January, the largest quantities are concentrated on the contract expiring the following December (after around 12 months), but contracts expiring in December of the following four years (i.e., after around 24, 36 and 48 months) are also traded, as well as contracts with maturity shorter than 12 months. By following rightwards the staircase-shaped lines, the colour tends to become darker: this indicates that the exposure on that contract increases as maturity approaches. In particular, the graph shows some diagonal lines referring to contracts expiring in March, in line with the obligation of surrendering EUAs in April.

Figure 9 – Future outstanding quantities by maturities.
(daily data; 2021-2023)

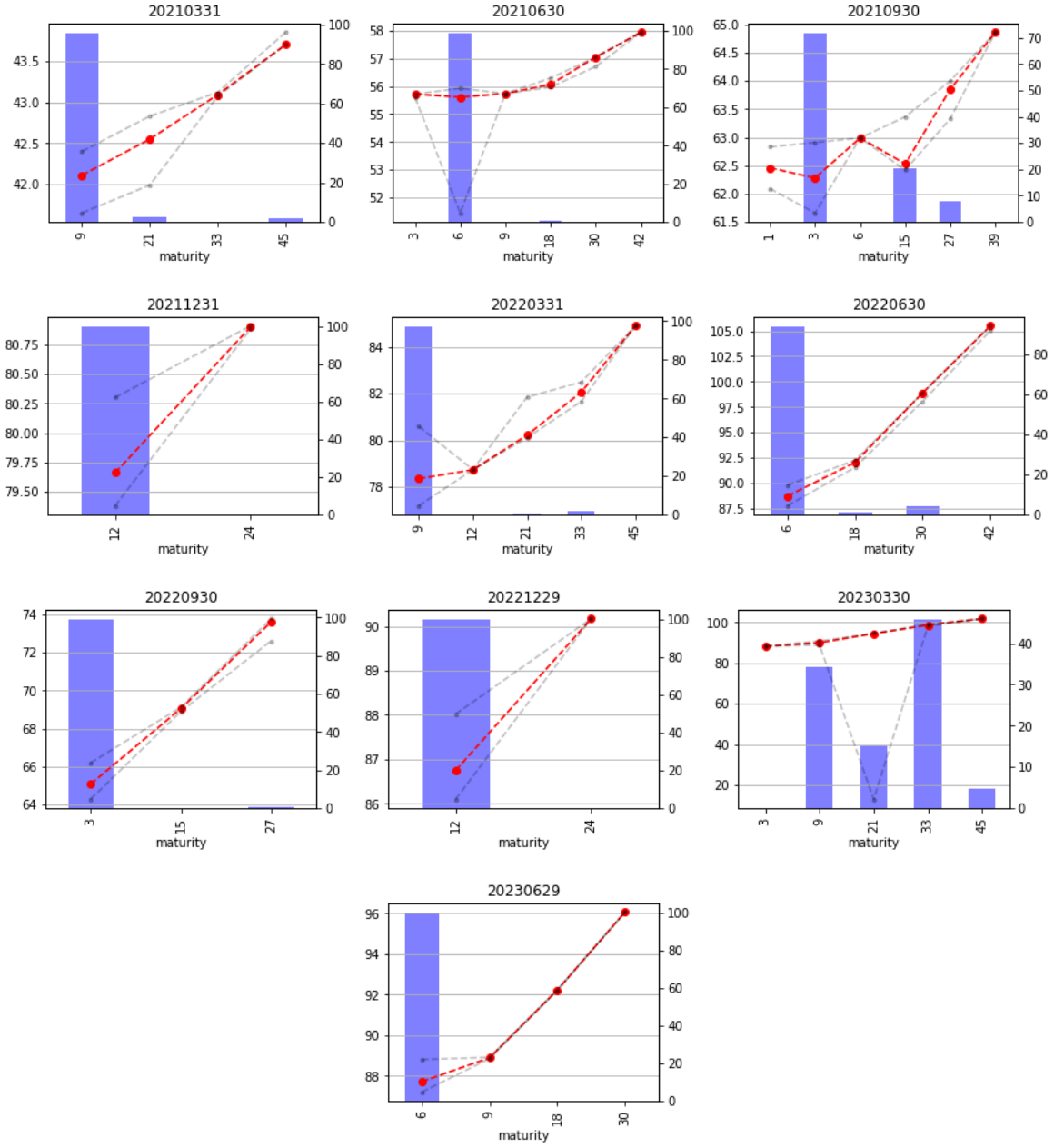


Source: EMIR data available to Banca d'Italia.
For each trading day, referred to as *reference date* in EMIR, we report futures outstanding quantities (colour scale on the right of the figure) by months until maturity (left-hand side axis).

The next figure shows the term structure of future prices and the underlying quantities at the end of each quarter from March 2021 to June 2023. To obtain more robust price estimates we consider all available information, that is all trades and not only those involving Italian counterparties. The red line is the future curve, i.e. the median price of the transactions for a given maturity, and the bars represent the quantities of the traded maturities as a percentage of the total (across maturities) quantities of that trading day. It should be noted that these are prices related to real transactions, not consensus prices. As already seen in Figure 9, most of the activities are focused on the contract

expiring in December of the same year, although in some cases (e.g., September 2021 and March 2023) there are significant transactions also for futures expiring in December of the following years.

Figure 10 – Future term structure.



Source: EMIR data available to Banca d'Italia.

For each end of quarter, we report the term structure based on all transactions. On each analysed trading day, we report on the horizontal axis the maturities (as number of months) for which at least a transaction occurred on that trading date. For each maturity, median (dashed red lines; lhs), 5th and 95th quantile prices (grey dashed lines; lhs) and related quantities (rhs) as percentage of the total are shown. The bars represent, for each maturity, the quantities that were traded on that day, as a percentage of the total quantities of that trading day.

The curve is generally upward sloping ("contango"), denoting expectations of rising EUAs prices.[37] While for other commodities, like oil, a rapid increase of spot prices often results in backwardation, since prices are expected to later decrease, this is not the case for EUAs. Future prices have historically increased along with spot prices, reflecting the expectation that prices are unlikely to decrease significantly in the long run. We argue this should be correlated with the implementation of the fourth phase of EU ETS and the consequent decreasing of free allocated EUAs; that is also confirmed, for instance, by the 2022 Annual Report of ENI, one of the major Italian compliance firms.[38]

5. Conclusions

Derivatives on CO_2-emission allowances are gaining an increasing interest by the European firms subject to carbon compliance programs, who can use these derivatives to manage the risks associated with the rising price of the allowances. There is also a growing attention by banks and other financial players, who act as intermediaries in the European emission trading scheme (ETS) market, buying allowances at auctions and selling derivatives to compliance entities.

This work contributes to a better understanding of the Italian market for CO_2-emission derivatives and its significance in environmental risk management for Italian companies. Exploring the transactions carried out by Italian counterparties reported in the EMIR database, we found that the CO_2-emission market, which represents nearly 14% of the overall Italian commodity derivatives market, has recently shown a rapid growth. Moreover, we found this market has become less concentrated among non-financial firms, which mainly use futures on emission derivatives, probably to hedge the risks associated with the obligation to participate in the EUAs market and the uncertainty about the amount and spot price of the EUAs to be surrendered. A small number of banks, who likely act as intermediaries, are participating in the market. For all those banks the emission derivatives represent a very small fraction of the overall gross notional of their derivatives portfolio. According to our network analysis, there is a first major cluster with center at a bank with a large number of direct connections with non-Italian entities; there is a second cluster including another bank and a few Italian non-financial corporations with a remarkable activity in CO_2 derivatives; and finally there is a third minor cluster, centered at a third bank and connected with several Italian non-financial corporations characterized by limited activity in EUAs derivatives. Given that over 80 per cent of Italian compliance firms did not use EUAs derivatives, the number of participants in the market has

[37] The scale of the y-axis in Figure 10 changes across graphs to improve data visualization. For some dates the scale magnifies the perception of the steepness of the curve.
[38] See https://www.eni.com/assets/documents/eng/reports/2022/Annual-Report-2022.pdf.

room for enlarging in the future. Finally, we focused on futures contracts, which are the most traded kind of derivatives, noticing a certain concentration on a few maturities, especially those at the end of the year. Moreover, the term structure of the futures shows a "contango" situation, with a price curve generally upward sloping, denoting expectations of rising EUAs prices.

The richness and granularity of EMIR data offer possibilities of deeper investigations under different directions: by studying the determinants of non-financial firm hedging strategies, after matching EMIR data with balance-sheet data; by studying the statistical properties of the time series of spot and futures prices and the pricing framework of option contracts to explore the risks of these financial products, once time series become sufficiently longer. Additional analysis could also include: the extension of the work to all euro-area entities, in order to have a better understanding of the overall market structure; qualitative case studies on single counterparties who are relevant for that market.

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