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Climate change risks and the energy and emission allowances market

An analysis based on EMIR data

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1. Introduction

The recent volatility in energy markets triggers the question of how these markets function. Furthermore, commodities (energy) and commodity derivatives on energy and emissions will be of growing importance for the transition to a more carbon-neutral European economy. Better knowledge of how these markets interact, in combination with existing clearing practices, is therefore of increasing relevance. The European Union (EU) Green Deal [2021] assigns a significant role to the EU Emissions Trading System (ETS) for the trading of EU Emission Allowances (EUAs) to achieve climate neutrality in the EU by 2050. EUAs are classified as financial instruments under the Markets in Financial Instruments Directive (MiFID II) as of January 2018.

This research on the Euro Area (EA) European Market Infrastructure Regulation (EMIR) Trade Repository (TR) data intends to promote knowledge and better understanding of how the EA commodity derivatives on Energy and Emissions and related clearing practices interact. Climate Change Risks (CCRs), both physical and transitional, have already led to some events with profound consequences for these markets and their participants. One of these events is described and analysed based on the EMIR TR database to the extent possible due to confidentiality issues. The results provide valuable insight into market participants and their clearing behaviour. They also show how cleared markets are concentrating towards a single central counterparty (CCP) (market share). This may pose a challenge in the future with the expected increasing importance of commodities and commodity derivatives markets. Overall, specific disruptions in the commodity derivatives market caused by CCRs could potentially have an impact on the business of a CCP. As CCRs are here to stay, it is important for market participants, as well as authorities and regulators, to take these risks into account.

This paper starts by describing the characteristics of the research project. It is built on earlier research from DNB on Energy and Emission derivatives. Due to data confidentiality, that research was limited to EMIR TR data with at least one participant from the Netherlands (NL) in the derivatives transaction, being a CCP, clearing member or client. As the ECB (European Central Bank) has access to data on all EA derivatives transactions, this much broader database could provide more reliable and EA-wide insights into this part of the commodities world that is of growing importance.

The research was conducted by DNB between June and November 2021 based on a secondment at the ECB. As we were able to include data up to and including November 2021, the turmoil in energy markets (significant rises in prices of gas in October) has also been covered. The further increase in prices because of the crisis in Ukraine, however, is out of scope.

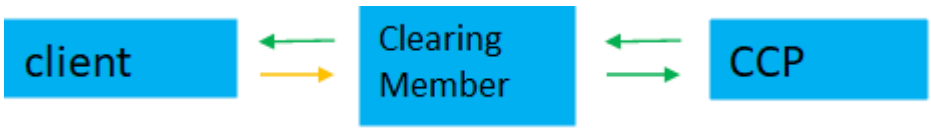
2. Data and scope

In this research we analysed derivative data on energy and environmental derivatives as reported under EMIR. Under EMIR all EU counterparties having derivative trades are obliged to report them to a Trade Repository (TR). In this section we describe the scope of the dataset we used and touch on the issue of double reporting. As this dataset suffers from various data quality issues, we describe our data cleaning and preparation process more extensively in Annex 1.

The complete EMIR TR dataset covers all trades throughout the EU. For this research we used the subset of this data that is available to the ECB, which, as the central bank of issue of the euro, has access to the subset of the EMIR TR dataset where at least one of the counterparties has EA authority. This means that not all EMIR-regulated trades were included in the ECB research, as those between non-EA counterparties are not accessible. This also holds for non-EU counterparties, as we only had information on non-EU counterparties if they had trades with EA counterparties. Thus, this research gives a full overview of the EA market and only a partial view of the non-EA market. This implies that, for example, all transactions between Nasdaq (a Swedish non-EA CCP) and a non-EA clearing member were not included. The Nasdaq event described in section 3.2.2 therefore does not include data from Norwegian clearing members as they are outside the EU and the EA.

We analysed all data starting from March 2018 to the end of November 2021 labelled as Energy or Environmental derivatives. We also exclude dates with incomplete data and trades with unrealistic values as explained in Annex 1. Under EMIR all EU counterparties are required to report their trades, resulting in double reporting of trades between two EU members in the dataset. Moreover, when a trade is cleared by a clearing member for one of its clients, that trade is reported between the CCP and the clearing member and between that clearing member and the client. If all three parties reside in the EU, this can result in up to four reports of the same trade, as shown in Figure 1 below. In our analysis we chose to view this as a single trade. If the other leg of the trade is also present, i.e., the trade of the CCP with the original counterparty before clearing, we view this as a different trade. We decided on this approach because our focus was on CCP exposure and both sides of the trade constitute a risk for the CCP. In the Annex we describe in more detail how we identified these double reported trades and reduced them to a single trade.

Figure 1: Trade from client to CCP with double reporting. Arrows indicate a report. The yellow arrow indicates a possibility that the client does not report the trade.



Margin calls are not included in this research. The EMIR TR dataset does provide information on margins, but unfortunately these are combined with other products at a portfolio level.

3. Results

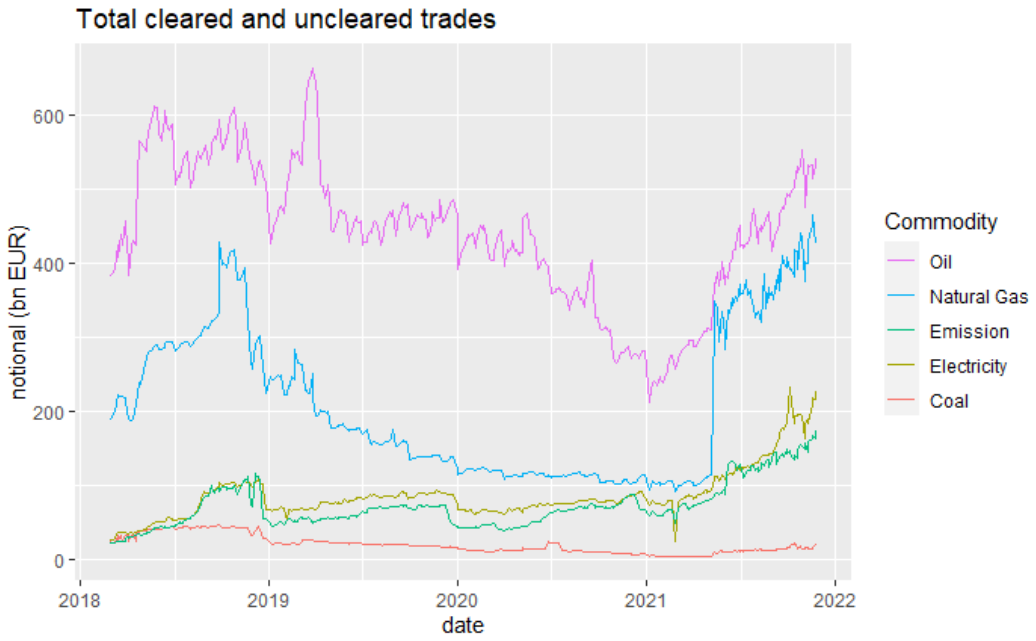
In this chapter we present the results of our analysis. In the first section we present a market overview, and in the following section we analyse a well-known climate related CCP event and the effects on the energy markets, respectively.

3.1 Market overview

As far as we are aware, no market overview of the energy and environmental commodity derivatives market based on EMIR TR data has previously been published. Distinct aspects of the market are mapped in this overview. First, we give an overview of the total outstanding notional per product. Second, we focus on clearing behaviour and present the landscape of all relevant CCPs in this market and their relation to trading venues.

Figure 2 shows the complete market overview of the energy and environmental derivatives market per commodity type for the period March 2018 until November 2021. The smallest categories of the environmental and energy derivatives, namely Inter-energy, Weather and Other, are excluded from the research because they only amount to a small share of the market (less than 1%).

Figure 2: Market overview of the complete market in notional in bn EUR for the period March 2018 until November 2021.



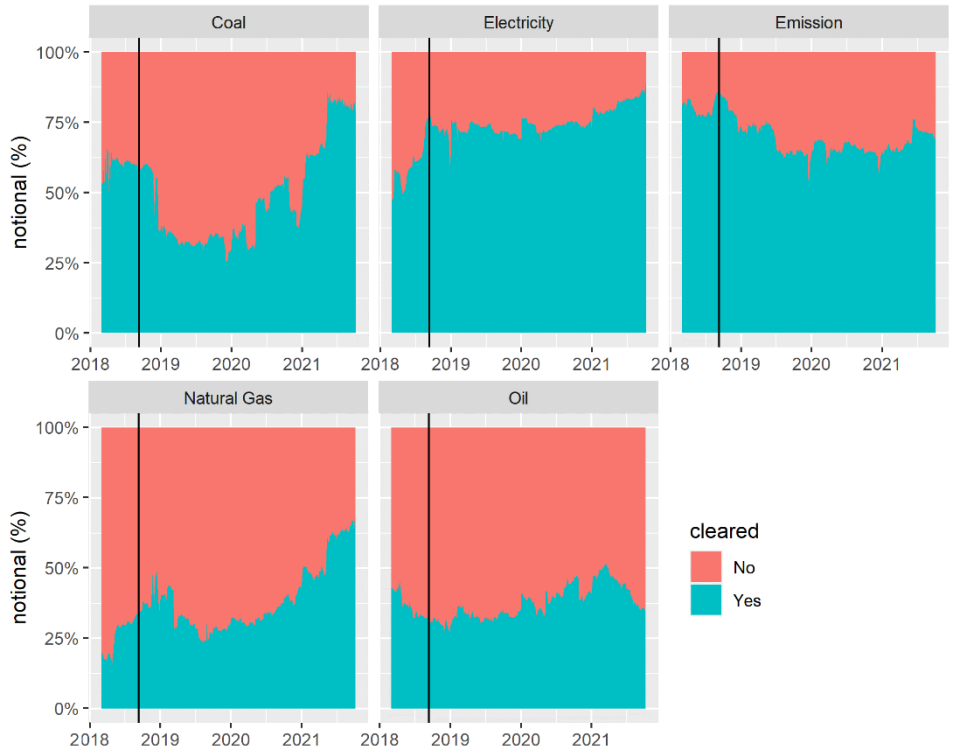
The largest commodity is oil. A large decrease in notional in oil derivatives can be seen in 2020 because of the Covid pandemic. A significant recovery can be seen in 2021. The rising trend of notional in oil, natural gas, emissions, and electricity in 2021 may also reflect recovering and expanding economies. In addition, the significant rise in the notional of natural gas in 2021 due to a combination of factors such as seasonal and distribution issues are shown in this figure.

In addition to these movements, a correlation between emission and electricity derivatives is clearly visible. This correlation can be explained by the obligation to possess emission certificates to produce electricity causing

emissions of greenhouse gases, for example by burning coal. We also find clear falls in the notional for all commodities at the end of every calendar year. This could be driven by accounting rules that take the last day of the year as the reference date for capital requirements, causing counterparties to decrease their positions.

Figure 3 below shows the percentage of the notional per commodity that is cleared at a CCP versus bilateral trades over time, also called clearing rates. The black line indicates the time of the climate-related events we will discuss in section 3.2. We find significant differences in these clearing rates between commodities. Looking at the past four years, the share of notional that has been cleared is highest for the electricity and emission derivatives markets. For coal and natural gas derivatives, the clearing rate has increased significantly since 2018, reaching levels of respectively around 65% and 75% of notional being cleared in November 2021. We find that these increased clearing rates in 2021 are the result of growth in the cleared market, while the size of the uncleared markets stays the same. Only around 30% of the outstanding notional in oil derivatives is cleared, which is significantly less than other energy commodities.

Figure 3: Percentage of notional cleared over time per commodity. The black line indicates the time of the climate-related events discussed in section 3.2.



Although oil derivatives have the lowest clearing rate of all energy commodities, it is the largest cleared market in absolute terms, since its total market share is much larger than the other commodities. It was not until the end of 2021 that the cleared notional of natural gas surpassed that of oil, due to the significant increase in natural gas prices. The same is true for the cleared electricity market, which at the end of 2021 was around the same size as oil.

Table 1 gives an overview of all active CCPs in the EA energy and emission derivatives market. We find that within the EU and the UK [1] there are some smaller CCPs present with a local function. Local in this context does not mean that they only clear trades within their own country, but that they have a more local/regional function. There are also a couple of CCPs that have actual global cross-border functions. As stated before, it should be noted that we do not have full insight for EU CCPs, as we do not see their trades with other non-EA counterparties. We furthermore find a large number of CCPs located outside the EU (ROW) which clear trades within this EA market, but most of them only clear insignificant amounts.

Table 1. CCPs active in energy and emission derivatives clearing and their location.

Location	CCP	Products
Euro Area (EA)	Athex Clear	
	BME Clearing, S.A.	Electricity
	Cassa di compensazione e garanzia S.P.A.	Electricity
	European Commodity Clearing AG	Electricity, Natural Gas, Oil, Coal, Emission
	OMIClear, C.C., S.A.	Electricity, Natural Gas
European Union (EU)	KELER KSZF	Electricity, Natural Gas, Emission
	Nasdaq Clearing Aktiebolag	Electricity, Natural Gas, Oil, Coal, Emission
UK	ICE Clear Europe Limited	Electricity, Natural Gas, Oil, Coal, Emission
Rest of World (ROW)	ASX Clear (Futures) Pty Limited	
	ASX Clear Pty Limited	
	B3 S.A. - Brasil, Bolsa, Balcão (BR)	
	Chicago Mercantile Exchange INC.	
	HKFE Clearing Corporation Limited	
	Ice Clear US, Inc.	
	Japan Commodity Clearing House Co.Ltd.	
	Japan Securities Clearing Corporation	
	Nodal Clear, LLC	
	Korea Exchange, Inc.	
	Singapore Exchange Derivatives Clearing Limited	

We also investigated the relationship between trading venues and CCPs, in both the cleared and uncleared markets. For this analysis we took a snapshot of the market on 12 December 2020 for electricity and emission derivatives. Our analysis shows that in this market trading venues and CCPs are members of the same group and are linked to each other one on one. Only in a few cases does a CCP appear to clear for more than one trading venue, but in that case those venues are also part of the same overarching group.

We also find that while all transactions at trading venues are centrally cleared, all over the counter (OTC) trades remain uncleared. This is the outcome of the previously described group situation. Once a trade is conducted at a trading venue it is automatically cleared at the corresponding CCP of the same group. In contrast, it is impossible

[1] ICEU (ICE Clear Europe) was in the EU before Brexit. As of 1 January 2021, it no longer falls under EMIR.

to clear any of the OTC trades, as CCPs only clear the exact contracts traded at their connected trading venues. This also suggests that the individual needs of clients are difficult to standardise and to make fit for trading at a trading venue and for connected clearing. Trading venues and CCPs as a rule trade and clear standardised products with a certain volume.

3.2 Impact of climate-related events

In this section we focus on the impact of a climate-related event in September 2018. This so-called "Nasdaq event", on which a lot of information can be found online, took place in the electricity derivatives market. Below we analyse the impact of this event. As the event was partly caused by changes in EU emissions policy, we also start with an overview of the cleared emission derivatives market.

3.2.1 The cleared emission derivatives market

Considering the cleared emission derivatives market more broadly, this market has four active CCPs (each with a notional of over €1 bn a day). We find that the notional increased in 2018 for all CCPs up to the time of the event, which we will discuss below, and stabilised shortly afterwards until the end of 2018, when the notional fell drastically. Every year, we see an end-of-year drop in the emissions market, which is driven by accounting rules that take the last day of the year as the reference date for capital requirements, causing counterparties to decrease their positions. However, the drop at the end of 2018 was much larger than usual, as the notional decreased by 65% of its original value, whereas a year later the drop was only around 35%. In 2020 the notional started increasing again only in June, instead of in the first part of the year, due to the Covid pandemic. As can be seen in Figure 2, the notional only recovered to its pre-event level of September 2018 at the end of the first half of 2021. As a result of the overall increased growth and volatility in energy prices, markets appear to have been experiencing substantial growth since the start of 2021. The recent market turmoil has not caused any default events among clearing members.

We also find an effect of an emissions policy change, the amendment to the 'Market Stability Reserve (MSR)'. This market-balancing mechanism was introduced in 2015 to control the flows of EU Allowances (EUAs) into the market each year with the aim of lifting carbon prices. The design of the MSR allows it to reduce or increase the total number of allowances in circulation (TNAC) by absorbing or releasing parts of the auction volumes. Predefined TNAC ranges trigger this MSR mechanism, defined by upper and lower thresholds combined with intake rates. The 2018 amendment temporarily doubled these parameters, from the start of the MSR until the end of 2023. In addition, it introduced an invalidation rule, which states that from 2023 onwards MSR allowances that exceed the previous year's auction volume cease to be valid.

Between May 2017 and September 2018, the prices of EUAs rose significantly, from €5 to €25 per ton. Due to the considerable market volatility experienced during this period, significant margin calls were necessary in September 2018, when the price of EUAs fell significantly in two days.

We find that the notional increased for all CCPs up to the time of the event and stabilised shortly after, reflecting the drastic price increase of emission rights in the first half of 2018, which came to a halt in September 2018 due to the MSR policy change. This behaviour can also be seen in the market overview in Figure 2, showing 300% growth in outstanding (cleared and uncleared) notional in September 2018 compared to March 2018. We find that the cleared market showed even stronger growth in notional of around 500%. After the event, both cleared and

uncleared notional stabilised up to the end of 2018. As discussed above, the end-of-year drop at the end of 2018 was larger than usual, compensating for the strong growth at the beginning of the year.

We investigated the behaviour of clearing members during the above-mentioned period to see whether clearing members or clients changed CCP due to the margin breach. We did not find any change in behaviour indicating that clearing members or clients moved their business to another CCP. This is related to the fact that the market is concentrated, which makes it hard to clear the same products at a different CCP.

3.2.2 The cleared electricity derivatives market

As in the case of emissions, we analysed the notional per CCP in the electricity derivatives market and its behaviour over time. The electricity market has more active CCPs than the emission derivatives market. Several CCPs have smaller, comparable, market shares. Also, there is a strong correlation between the emission and electricity derivatives markets. Hence, we see a sharp increase in the first half of 2018 and a drop in notional at the end of that year. Since early 2019 the outstanding notional in electricity derivatives had remained stable, with no major impact at the start of the coronavirus pandemic in March 2020. As of 2021, however, and in parallel with emission derivatives, the outstanding notional in electricity derivatives increased strongly, with almost exponential growth as of summer 2021, which, with hindsight, appeared to foreshadow the further increases seen in 2022.

The well-known Nasdaq event also took place in September 2018. This event was triggered by the widening spread of Nordic and German electricity prices in combination with the previously mentioned emissions policy change (the amendment of the MSR). In September 2018, unanticipated high rainfall after a dry summer affected Nordic electricity prices. The high rainfall in the Nordic region fueled market speculation that hydro reservoirs would be replenished faster than expected, making it cheaper to produce hydropower and resulting in lower electricity prices. At the same time, German electricity prices increased because of the amendment of the MSR. These developments caused market turmoil in certain commodity prices and a widening of spreads, leading to significant margin calls at certain clearing members. Due to positions relying on the correlation between Nordic and German electricity prices, these margin calls eventually led to the default of a clearing member [2]. The default also affected other clearing members of Nasdaq who had to make contributions to compensate for losses.

Interestingly, no disruption in the market on the day of the event is visible. Even though a default took place, this can be explained because derivatives run for longer periods. Hence it takes time for clearing members and clients to decrease their positions by either selling their contracts or waiting for them to mature. As in the case of the emissions market, we do find a larger drop in outstanding notional at the end of 2018, without a fast recovery in the following year, indicating that matured contracts were not renewed.

We further investigated the behaviour of clearing members two months after the event compared to just before. More specifically, we compared the outstanding notional held by clearing members in electricity derivatives at certain CCPs two months after the event and compared it to one week before the event. It was assumed that if we found multiple members with a low ratio, this could indicate that clearing members might have moved their clearing business to other CCPs because of the event. For example, in the case of Nasdaq, due to the management of the default that also required a financial contribution from non-defaulting clearing members and their clients, clearing members might have been motivated to stop clearing at Nasdaq. A change in clearing member behaviour could,

[2] This was an atypical clearing member, who, we expect, will not be allowed to be a direct clearing member in the current settings.

however, also be the result of the increased risk measures and policy changes made by Nasdaq in response to the event, for example regarding access policies for clearing members. In conclusion, we can state that some movement is visible, but nothing that clearly shows an impact of the default event. It is important to note that we find no evidence that clearing members moved their businesses entirely to another CCP after the event.

4. Recommendations and suggested follow-up work

We recommend building further knowledge and gaining insight into how energy and emissions markets with related clearing practices function under normal conditions and in stress situations. This could be helpful for good management of the transition process to a lower carbon-economy. Changes in policies affecting the transition path could entail transition risks which, especially when unexpectedly combined with physical effects such as heavy rainfall, severe drought, floods, or high/low temperatures, could lead to increased and abrupt volatility in prices and related margin calls. The research and analyses merit further work on the following points:

a. The level of concentration of the clearing market for emissions and electricity merits further attention from policymakers. About 70% of the emission derivatives are cleared. The clearing market for this product is concentrated. Three out of four of these CCPs are in the EU, one of which is in the EA. Due to the growing importance of the EU Emissions Trading System and the related importance of clearing facilities for market participants, this is an important finding that could merit further attention from policymakers, supervisors, and market participants. About 80% of electricity derivatives are cleared. The clearing market for this product is less concentrated but is dominated by a single CCP. Of the seven CCPs, six are in the EU, of which four are in the EA and one in the ROW. It is important to realise that the correlation between electricity and emissions is strong because electricity production often requires the use of emission allowances. We do not know the reasons behind the level of cleared versus uncleared per commodity, but it might be worthwhile investigating.

b. A specific feature of the electricity and emission derivatives market is its vertically connected structure, embedded in larger trading groups. The research shows a concentration of trading venues with a significant link to their own CCPs. Such a vertical structure can be profitable for innovation and efficient trading and clearing; on the other hand, it often means little choice for market participants and the non-existence of a backup possibility. These findings might be something for EU policymakers to consider, as concentration in these markets shows certain vulnerabilities in markets of increasing importance. This may also be helpful in assessing whether appropriate incentives to change corresponding vulnerabilities are advisable.

c. Due to the limited number of trading venues and connected CCPs, market participants have little choice when it comes to diversifying their business. Trading venues and CCPs have their own access policies that can be adjusted when deemed necessary, for example after certain events. This could lead to a further reduction in choice, triggering further concentration or a movement towards OTC trading. As the latter is not in line with the preferred centralisation of trading, clearing and settlement by authorities, this is also a key area for further attention.

d. Transmission channels in the ecosystem of energy and emission derivatives could lead to systemic risk. This research describes a climate change-related events that took place several years ago. In the meantime, several other climate change situations have occurred, for example at the beginning of 2021 due to an unusually chilly winter in the US. Moreover, as we were able to include data up to and including November 2021, the start of the turmoil in energy markets (significant rises in prices of gas in October) is also included in the data. This price volatility prompted both affected trading venues and CCPs to act and thus interact. Improved knowledge and understanding of these interactions and their influence on access, margin calls and other mitigations is deemed necessary to avoid systemic risk.

e. It is important to take the reporting obligation seriously, since a solid analysis is always based on good data quality. The quality of the TR data can be quite a challenge for the analysis. For example, we discarded

all Mondays and Wednesdays, as we found that on average the reports are of lower quality on those days. It is therefore important to stress to all parties involved, such as the European Securities and Markets Authority (ESMA), CCPs, clearing members and clients, the importance of their transaction reporting.

f. The scope of the research could be extended to other ESG-related derivatives, in both commodities and financial derivatives markets. These markets are of growing importance in accommodating the transition towards a more carbon-neutral economy. The focus of this extension could be based on market mapping for the ESG (Environmental, Social and Governance) derivatives markets and their main characteristics (current and future trends) and showing the main channels through which climate-related risks are transmitted to ESG derivatives markets. The feasibility of such an extension would need to be assessed on the basis of the granularity and quality of relevant EMIR data fields.

5. Annex 1

In this Annex we describe the data preparation and cleaning process. The first part describes which trades were selected and why. The second part describes how we solved multiple reporting issues.

5.1 Data selection

We analysed all data starting from March 2018 up to and including the end of November 2021. We decided to start in 2018, as from then on, the data quality vastly improved due to revisions in the EMIR. We selected all data with the energy or environmental commodity type. Since this research is aimed at investigating the effect of climate change risks on CCPs and their aggregate outstanding notional, we focused data cleaning on the notional and CCP field.

To avoid outliers in notional we discarded all transactions with a notional of less than €1,000 or more than €10 billion. Furthermore, we only consider days on which all TRs (Trade Repositories) report. We also discarded all Mondays and Wednesdays, as we found that on average the reports are of lower quality on those days. We are not sure what causes this. Since we are interested in broader trends over time, this is not an issue. To make sure that we had all available counterparty information, we only included trades for which both counterparties have a Legal Entity Identifier (LEI) code. If one of the two counterparties was identified as a CCP, we replaced the information in the CCP field with that counterparty, to improve the data quality of the CCP field. For cleared trades we required at least one of the counterparties or the CCP field to be filled with an ESMA-authorised CCP.

5.2 Multiple reporting

Under EMIR all EU counterparties are required to report their trades, resulting in double reporting of trades between two EU members [3]. Moreover, as explained in section 2, one side of a cleared trade can show up four times in the dataset. Since the analysis focuses on the aggregate notional, we had to reduce this to a single trade. In our analysis we used a 'CCP – clearing member – client' preference strategy, which means that if the trade is reported by the CCP, this information was used. Where the trade is not reported by a CCP, the information provided by the clearing member was used. Where both the CCP and the clearing member do not report, the client's reporting was used. This preference is based on the more reliable and thorough reporting by CCPs practised by clearing members. Especially when clients are smaller entities, their reporting is less reliable compared to the reporting of CCPs and/or clearing members. To identify CCPs we used the list of ESMA-authorised CCPs. We then identified clearing members as all counterparties having direct trades with any of these CCPs. Finally, all other parties were labelled as clients. We then used this labelling to identify which reports are used to calculate the notional and which are to be discarded.

[3] These trades only show up in the ECB dataset if at least one of the two counterparties is an EA member.