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The Long and Short of It: The Post-Crisis Corporate CDS Market

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Abstract

We establish key stylized facts about the post-crisis evolution of trading and pricing of credit default swaps. Using supervisory contract-level data, we document that dealers become net buyers of credit protection starting in the second half of 2014, both through reducing the amount of protection they sell in the single-name market and through switching to buying protection in the index market. More generally, we argue that considering simultaneous positions in different types of credit derivatives is crucial for understanding institutions' participation decisions and how these decisions affect prices in these markets.

Key words: CDS positions, CDS transactions, dealer market power

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1 Introduction

The credit default swap (CDS) market, made notorious in the wake of the 2007–2009 financial crisis, is the third biggest over-the-counter derivatives market in the world, with $8 trillion notional value of outstanding CDS as of June 2018 (BIS, 2018). Due to the importance of the market to the world financial system, sweeping regulatory changes – meant to address fragilities uncovered during the financial crisis – were implemented globally. These regulations have not only changed the structure of the market, but have also allowed greater visibility into the previously opaque bilateral, over-the-counter market through extensive data collection. In this paper, we exploit such supervisory granular data to study the properties of exposures taken through the CDS market to corporate reference entities in the United States and Europe: which institutions use these contracts, what kind of exposures do they take, when do they take them, and what affects the prices of these bilateral exposures.

We use supervisory positions-level data from the CDS trade repository maintained by the Depository Trust and Clearing Corporation (DTCC) to document properties of both existing and new positions, such as the credit risk profile of the underlying, maturity of the swap, location of the party and counterparty to the trade, as well as the type of credit derivative used. Using the transactions-level counterpart to the positions data, we then examine to what extent designated dealers in the market exert price-setting power when transacting with non-dealer customers and whether this effect is smaller for clearing-eligible contracts. Our paper thus serves to provide stylized facts on the evolution of the CDS market post-crisis across different types of contracts, counterparties and risk exposures. As we discuss in greater detail in Section 3, unlike the prior literature, we study institutions' choices to participate (or not) in all four of the most common CDS products jointly, and show that having this holistic view of exposures is necessary for understanding the evolution of the market in response to both industry- and regulatory-led innovations.

We document five facts about the structure of the CDS market for U.S. and European corporate credit derivatives. First, while historically dealers were the sellers of protection in the index CDS market, they became the buyers of protection in the second half of 2014. At the same time, dealers have continued their historical patterns of selling protection in the single-name market and buying protection in the levered index markets (index tranche and index options). Thus, considering different types of CDS products simultaneously is crucial to understanding institutions' exposures to credit derivatives.

Second, index options have replaced index tranches as the more prevalent levered derivative product written on index contracts. That is, while historically institutions used levered products to get exposure to a particular range – or "tranche" – of losses on a CDS index, the introduction of options on the index has led to institutions levering the whole index position.

Third, the maturity at inception of exposures taken through the CDS market has been declining over time, with index CDS contracts trading almost exclusively with five-year maturity at the end of our sample. Thus, not only has the gross notional of the aggregate CDS exposure declined since the financial crisis, but so has the duration of the exposure.

Fourth, most of the decline in the gross notional outstanding in single-name CDS observed since the crisis has been in single-name contracts not eligible for (voluntary) clearing through a central counterparty. Thus, the market for plain-vanilla CDS in the U.S. essentially migrated to being wholly centrally cleared even without the introduction of mandatory clearing rules for single-name CDS.

Finally, clearing eligibility does not uniformly reduce transaction costs. For U.S. reference entities, clearing eligibility reduces the transaction costs faced by buyside customers when buying protection from dealers and the discount earned by dealers when buying protection from customers but does not completely equalize the transactions costs faced by dealers and customers. In contrast, for European reference entities, clearing eligibility increases the average transaction costs for single-name contracts referencing lower-rated reference entities but equalizes the transaction costs faced by customers and dealers in the market for European indices.

This paper also serves as a primer on the overall structure of the CDS market in the post-crisis regulatory environment. We provide a summary of the characteristics of the most commonly traded types of CDS contracts, and the most salient features of the evolution of the market since its inception in the early 1990s. The Dodd-Frank Act introduced multiple changes that have been impacting how CDS contracts have been traded in U.S. since the crisis. These changes include registration requirements for market participants to trading, central clearing, and reporting of OTC derivative positions.[1]

As we discuss in greater detail in Section 3.1, when reviewing the existing literature and the paper's contribution, DTCC provides different subsets of the data, depending on the relevant authority's purview. As a prudential supervisor, the Federal Reserve is entitled to view positions and transactions for which at least one counterparty is an institution supervised by the Federal Reserve or for which a supervised institution is the reference entity. The concern then would be that any empirical finding might be biased on the sample selection. We, however, study the coverage of the positions data collected for supervisory purposes in the U.S. over time relative to the universe of trades maintained by the DTCC.[2] We find that the weekly snapshot of open positions capture a large fraction of the total market activity covered by the DTCC trade information warehouse (TIW). In particular, for a median week in our sample, the supervisory data capture over 70% of the single-name contracts, over 60% of the index contracts, and over 85% of index tranche contracts[3] covered in the TIW in terms of the number of contracts outstanding and the gross notional of the

[1]Additional changes to the regulatory environment that are not discussed in this primer include changes to capital charges for derivative positions; the introduction of liquidity requirements, which are also affected by the amount of derivative positions that an institution holds; and the introduction of the Volcker rule, which restricts banks from participating in proprietary trading and owning or investing in hedge funds and private equity funds.

[2]DTCC estimates that the TIW covers about 98% of globally traded CDS.

[3]The coverage of index tranche trades between dealers and customers has declined to about 75% at the end of 2018. This suggests that customers have shifted their activity to institutions not regulated by the Federal Reserve. Our results pertaining index tranche contracts are robust to this coverage decline.

contracts outstanding.

The rest of the paper is organized as follows. In Section 2, we describe the four credit derivatives contracts that we focus on in this primer – single-name CDS, CDS Index, index tranche, and index options – and how the trading of these contracts was affected by the recent regulatory changes. Section 3 gives a short overview of the supervisory version of the DTCC data, discussing the differences and similarities with other proprietary datasets used in the prior literature. We describe the properties of existing and new positions in Section 4, and document the pricing strategies followed by different pairs of counterparty types in Section 5. Section 6 concludes.

2 Overview of the Credit Default Swap Market

A CDS is a bilateral agreement between a protection buyer and a protection seller in which the buyer agrees to pay fixed periodic payments to the seller in exchange for protection against a credit event of an underlying. The underlying may be a single reference entity (single-name CDS), a portfolio of reference entities (CDS Index), or a particular amount of losses in a basket of reference entities (tranche CDS). In this section we review these different contracts, including how they are priced and traded. We also review the industry- and regulatory-led changes to the trading mechanism of these over-the-counter (OTC) derivatives.

2.1 Single-Name CDS Contracts

The single-name CDS contract insures the buyer of protection against the default of a single corporation, a sovereign or a municipality. A credit event triggers a payment from the protection seller to the protection buyer; in exchange, the buyer pays quarterly coupon payments to the seller until either default or contract expiry. The reference obligations are often senior unsecured bonds. The ISDA Master Agreement, published by the International Swaps and Derivatives Association, specifies the terms and conditions of the contract, particularly the reference entity, the deliverable obligations, the tenor of the contract, the notional principal, and the credit events against which the contract insures. Standard credit events include bankruptcy, failure to pay, obligation default, obligation acceleration, and repudiation/moratorium. The CDS contract may also insure against debt restructuring, a credit event that would not necessarily result in losses to the owner of the reference obligation.

In September 2014 credit event triggers were amended for new transactions on financial and sovereign reference entities, as well as the restructuring and bankruptcy credit events. The changes included a government-initiated bail-in for CDS contracts on financial reference entities; a split between senior and subordinated, if a government intervention or a restructuring credit event occurs; and, an Asset Package Delivery provision, under which existing bonds that were deliverable before the bail-in will be deliverable into the post-bail-in auction to determine the final auction price.

Prior to 2005, when a credit event occurred, the CDS contracts were physically settled: the protection buyer delivered the cheapest-to-deliver bond issued by the reference entity that could be delivered, and in turn received the bond's face value. With the rapid growth of the CDS market, however, there were many cases when the volume of CDS outstanding far exceeded the volume of deliverable bonds, and the market transitioned to cash settlement. To determine the fair price of the defaulted reference entity, an auction mechanism was introduced in 2005. Creditex and Markit administer these auctions and publish their results on www.creditfixings.com. In the auction, buyers and sellers of protection settle on the *net* buy or sell CDS position, reducing the amount of bond trading necessary to settle all contracts.[4] The auction mechanism determines the inside market midpoint for the physical settlement of the CDS contracts. The protection seller then pays the difference between the

[4] For a detailed discussion of the auction mechanism and its efficiency, see Helwege et al. (2009), Gupta and Sundaram (2015), Chernov et al. (2013), and Du and Zhu (2017).

par value and this auction-identified price per unit of the contract notional to the protection buyer. Gupta and Sundaram (2015), Chernov et al. (2013), and Du and Zhu (2017) study theoretically and empirically the auction mechanism to determine settlement price.

Another change that affected single-name CDS contracts during our sample period is the standard roll frequency. In December 21, 2015, instead of rolling to a new on-the-run single-name contract each quarter on the 20th of March, June, September, and December, single-name contracts only roll to new contracts in March and September. For example, under the old convention, on June 2015 there was a move to a new 5-year single-name contract, maturing on September 20, 2020. That 5-year contract was considered as on-the-run for 3 month period. Under the new roll convention, a 5-year single-name contract that started trading on March 20, 2016, and maturing on June 20, 2021, was considered on-the-run until September 20, 2016. Then, a new on-the-run 5-year single-name contract have started trading. The goals of this change were aligning with the roll frequency of CDS Index contracts and improving liquidity around the new semiannual roll dates.[5]

2.2 CDS Index Contracts

A CDS Index is a portfolio of single-name CDS. A protection buyer is protected against the default of any constituent in the underlying portfolio. In return, the buyer pays quarterly coupon payments to the protection seller. Like a single-name CDS, if there is a default, the protection seller pays par less recovery determined in the auction. Today, CDS Indices are the most common instruments for assuming credit risk exposure, and they are more liquid and trade at smaller bid-ask spreads relative to a basket of cash bonds or single-name CDS contracts. The most popular CDS Index families are Markit CDX indices, covering North American and Emerging Markets, and International Index Company (IIC) iTraxx indices, covering Europe, Australia, Japan and non-Japan Asia. The CDX Indices family includes

[5]For further details, see ISDA's "Frequently Asked Questions, Amending when Single Name CDS roll to new on-the-run contracts".

the North American Investment Grade CDX index (CDX.NA.IG), the North American High-Yield CDX Index (CDX.NA.HY), and the CDX Emerging Markets Index (CDX.EM). The iTraxx Indices family includes the iTraxx Europe index and the iTraxx Crossover index. The combined daily traded volumes in the Markit CDX (North America and Emerging Markets) and Markit iTraxx (rest of the world) indices were approximately $38 billion on average in 2018, representing on average 1,003 daily transactions, $5.6 trillion of gross notional and $906 billion of net notional outstanding (see ISDA SwapsInfo website).

For the credit exposures we later calculate in the paper, we consider the three most popular indices, and their sub-indices: CDX.NA.IG, CDX.NA.HY, and iTraxx Europe. The CDX.NA.IG index is a portfolio of 125 North American reference investment-grade-rated corporate firms, with $13 billion average traded volume and 226 average daily transactions in 2018. There are also sector sub-indices of the CDX.NA.IG index (consumer cyclical, energy, financial, industrial, and telecom, media and technology), and CDX.NA.IG.HVOL that includes the reference entities with high volatility. As of 2018, the latter sub-index is no longer actively traded in the market. The CDX.NA.HY index is a portfolio of 100 North American high-yield-rated corporate firms, with $6.2 billion average traded volume and 276 average daily transactions in 2018. The CDX.NA.HY has been broken down into two rating sub-indices: CDX.NA.HY.B and CDX.NA.HY.BB. The iTraxx Europe index comprises 125 equally weighted investment-grade European reference entities. The iTraxx Europe family also includes three sector sub-indices, covering non-financial, financial senior, and financial sub, and a HiVol index, consisting of the 30 widest spread non-financial names. The iTraxx Crossover index is composed of up to 75 sub-investment-grade European entities.

Unlike benchmark bond indices that are market value-weighted, the constituents of these CDS indices are equal-weighted by notional, and provide the same default exposure as buying/selling CDS on each underlying firm. It is important to note that although sectoral representation is taken into consideration in constructing an index, larger banks and broker-dealers are excluded from the CDX indices. Historically, the indices were owned by the International Index Company Limited (iTraxx family) and CDS IndexCo LLC (CDX family), which were themselves owned by a consortium of large dealers; thus, historically, including bank obligors in the indices would have constituted a conflict of interest. In the current market structure, a small set of large dealer participants still dominates the volume of transactions. Therefore, as a seller of protection, a dealer would expose the buyer of protection on an index to "wrong way" risk – that is, the risk that the seller of protection is exposed to the same risk as the underlying – if that index were to include the dealer as a constituent. As a buyer of protection of the index, the dealer would be buying protection against its own default, raising questions about the legality of the contract. Therefore, excluding banks and broker-dealers as constituents and including other financial firms in the index allow market participants to gain credit exposure to a diversified basket of firms.

The composition of the basket is determined when the index is rolled to the market. Once the composition of an index is determined, the constituents remain unchanged throughout its lifetime, unless a credit event is triggered for one of the constituents, in which case it is removed without replacement and settled separately. The protection seller pays the loss on default to the protection buyer based on trade notional and the weighting of the name. A new *version* of the index is published, assigning a zero percent weight on the triggered entity. The contract continues to its full term at a reduced notional amount as the defaulted name is removed from the portfolio. Theoretically, the version of the index with the defaulted constituent should not be traded after the default date. In practice, however, the version including the defaulted entity does continue to be traded until the recovery value is determined in an auction, because dealers have historically hedged their tranche positions using the index and only when the auction results are finalized can the attachment and detachment points of a new version of a tranche be determined.

As time passes, the characteristics of the constituents might deviate from the desired profile of the index. Therefore, a new index *series* is introduced twice a year in March and September with extended maturity and updated constituents. This series is considered the on-the-run series. Though trading continues in previous series, the liquidity for off-the-run series is diminished relative to the on-the-run series. In the roll, entities that no longer qualify for inclusion in the index are removed and new entities are added to keep the total number of reference entities in the index constant, with the majority of names remaining unchanged.[6] In particular, 4% and 7% of the CDX.NA.IG and CDX.NA.HY constituents, respectively, are replaced on average in each roll.[7]

The set of rules governing the adjustment process has evolved over time, tracking market developments. The key change happened in March 2011, when the DTCC Trade Information Warehouse data were utilized for the first time in determining the liquidity of the potential constituents.[8] More recently, since the liquidity of single-name CDS has become a concern and to better match the cash market counterpart, the rules governing the constituents of the CDX.NA.HY index family were updated in September 2015. A sector-based criterion to avoid excess weighting of certain sectors was added, and the liquidity-based criteria to avoid single-name CDS with insufficient liquidity were tightened. Entities that fail to satisfy the rating requirement due to an upgrade or a downgrade or are not sufficiently liquid are replaced by the most liquid entities that meet the necessary credit rating.[9]

In terms of pricing, a CDS index should in theory trade at its intrinsic value, which is approximately equal to the duration-weighted average of the underlying single-name CDS expressed as a price value of a basis point. However, the market value of a CDX index is determined by supply and demand, often resulting in a spread differential between an index's intrinsic value and its actual market value. Junge and Trolle (2014) use this differential to

[6]For an analysis of the effects on the single-name CDS spreads of entering and exiting the index, see Bai and Shachar (2015).

[7]For comparison, while there is no periodic adjustment of the S&P 500, changes are made when needed, removing a company from the index when it violates one or more inclusion criteria or when a company is involved in a bankruptcy, merger, takeover or another significant corporate restructuring. As a consequence 25 to 50 index replacements take place every year, which represents a 5% to 10% turnover of the index composition.

[8]Markit creates a "Liquidity List" after each publication of the "6 month Analysis Top 1,000 Single Names" report published by DTCC. The "Liquidity List" is used to determine roll exclusions and inclusions.

[9]For current index rules for CDX.NA.IG, CDX.NA.HY, and iTraxx see Markit's website.

construct a measure of CDS market illiquidity. They find that CDS contracts with higher liquidity exposures have higher expected excess returns for sellers of credit protection and trade with wider CDS spreads, with liquidity risk accounting for 24% of CDS spreads on average.

2.3 Index Tranche CDS Contracts

It is also possible to assume a long or short credit exposure to a particular portion of the index loss distribution by trading a tranche on a CDS index. An index tranche is defined by its attachment (minimum level of losses) and detachment (maximum level of losses) points of the loss distribution. For example, an equity tranche with attachment at 0% and detachment at 5% will absorb the default of the first 5% of reference entities in the index. When a credit event is triggered, the appropriate tranche is adjusted for the reduced notional (based on loss-given-default) and a new detachment point is calculated for the number of remaining names in the index.

Figure 1 summarizes the relationship between the single-name contracts forming an index and tranche contracts on the index, using the CDX.NA.HY as an example. The CDX.NA.HY includes 100 North American reference entities with a high-yield rating, and has an equity (absorbing the first 10% of defaults in the index), a junior mezzanine (absorbing the next 5%), a senior mezzanine (absorbing the next 10%), a junior senior (absorbing the next 10%) and a super senior tranche (absorbing the last 65% of defaults in the index). Consider an investor that buys protection on the equity tranche with a notional of $10 million. When a name in the index defaults, with loss-given-default (LGD) set at 35%, the payout from the protection seller is

$$\begin{aligned} \text{Payout} &= (\text{Notional} \times \text{LGD} \times \text{Weighting}) / \text{Tranche Size} \quad (1) \\ &= (\$10,000,000 \times 0.35 \times 0.01) / 0.1 = \$350,000. \end{aligned}$$

The equity tranche is then adjusted for the reduced notional (based on the 35% LGD) and 9.65% of the notional remains in the tranche. The new detachment point has to be adjusted for the remaining names in the index: using a factor of 0.99, the equity tranche for new trades now becomes a 0-9.9% tranche. The principal of the other tranches is unaffected, but they now have a smaller cushion protecting them against further losses.

A few papers have examined the pricing of CDX tranche contracts. Coval et al. (2009) find that in 2004Q3 – 2007Q3 senior CDX tranches have offered too little compensation for the market risks to which they were exposed, when compared to the compensation investors were able to earn in the bond and option markets for bearing similar market risks. Collin-Dufresne et al. (2012) argue that senior index tranches provide the risk-neutral probabilities of catastrophic risks being realized in the economy. Seo and Wachter (2018) incorporate investors preferences, consumption and firm cash flows to a rare economic disaster model to explain spreads of senior CDX tranches before and during the financial crisis.

2.4 Index Options

Credit default options (or credit default swaptions) give the buyer the option of entering into a CDS contract at a future date. These options, similar in structure to more commonly referenced interest-rate options, provide investors with a platform to take positions on volatility in credit markets or tailor their directional spread views and credit exposure. Two types of CDS index options trade: a holder of a "payer option" has the right but not the obligation to buy protection (pay coupons) on the underlying index at the specified strike spread level on expiry ("European put"); a holder of a "receiver option" has the right but not the obligation to sell protection (receive coupons) at the strike spread level ("European call").

If a default happens among the index constituents prior to the expiry of the option, the buyer of a payer option (seller of a receiver option) can trigger a credit event on exercise of the option. Since the buyer of the payer option receives any losses due to default, payer options may be exercised even if the index spread is below the strike of the option. The total payoff to a CDS index option thus has two components: payoff due to the difference between the spread level at expiry and the strike of the option, and the payoff due to any default losses. Although the credit default options market has existed since 2003, these derivatives only gained widespread traction in 2011. Today, more than 60% of the options on the CDX.NA.IG and the CDX.NA.HY are puts.

Since April 2009, single-name CDS, index CDS, and CDS index options have been traded with a fixed coupon and an upfront payment from the buyer to the seller that makes the expected present value of the protection bought equal to the expected present value of protection sold, conditional on the fixed spread chosen and common assumptions of the recovery rate in case of a credit event.[10] For both single-name and index CDS, the fixed coupon payments from the protection buyer to the protection seller are made on a quarterly basis, using 360 days-per-year as the convention.[11]

2.5 The Evolution of the U.S. CDS Market

Although the CDS market has been in existence since the early 1990s, there were few changes to the contract structure and trading mechanisms prior to the 2007–2009 financial crisis. We now review industry- and regulatory-led changes in the U.S. CDS market, summarized in the timeline in Figure 2.

The industry-led changes focused on revisions to the ISDA Master Agreement – the document specifying CDS standard contract terms – aiming to bring greater standardization and substitutability to CDS contracts. On the back of operational inefficiencies and back-

[10]The rapid growth of the CDS market in the early 2000s was reflected not only in the enormous levels of gross notional amount outstanding, but also in the operational backlog. Therefore, the CDS contract and its trading conventions were changed in April 2009 as part of the Big Bang Protocol in order to create a more standardized contract. A more standard contract streamlines netting across trades and facilitates centralized clearing.

[11]CDX.EM, the emerging market CDS index, is an exception, with semiannual payments.

logs, the Big-Bang and the Small-Bang Protocols were introduced in April and July 2009, respectively, to eliminate redundant offsetting trades and to facilitate centralized clearing. The Big Bang introduced four main changes: (1) an auction mechanism to determine the recovery rate following a credit event; (2) Determinations Committees to decide whether a credit or succession event has occurred; (3) a "looking back" period to determine the effective period of the protection; (4) and a fixed coupon (either 100 or 500 bps) for single-name North American CDS and an upfront payment that is exchanged at the time of the trade. These changes were followed by the Small Bang, which applied similar changes to European corporate and Western European sovereign CDS, introducing fixed coupons (25, 100, 500, and 1000). The Big Bang Protocol also eliminated restructuring as a credit event in new North American, corporate single-name contracts, while European corporate CDS continue to trade with Modified-Modified Restructuring as the standard convention. These steps toward standardization made single-name CDS contracts more aligned with the standard corporate CDS indices.

Additional contractual change, as we already mentioned in Section 2.1, came into effect in September 2014 after credit events during the financial crisis exposed flaws in the ISDA's 2003 Definition. Relative to ISDA 2003, the key changes introduced by ISDA 2014 include a new credit event that covers a possibility of governmental intervention; deliverables in case of bank bail-ins; and further clarification on the deliverability of an obligation in case of a credit event ("Standard Reference Obligation").

Beyond the industry-led contractual changes, regulatory reforms included in the Dodd-Frank Act revamped the U.S. CDS market in an attempt to ameliorate the vulnerability of institutions linked by a complex web of OTC credit derivatives. Title VII of the Dodd-Frank Wall Street Reform and Consumer Protection Act provided a comprehensive framework for the regulation of the OTC swaps markets, including CDS, imposing registration requirements for market participants to trading, central clearing, and reporting of OTC derivatives, to mitigate counteparty risk and to bring forth more pricing transparency. The Dodd-Frank

Act divides regulatory authority over swap agreements between the CFTC and the SEC. The CFTC has primary regulatory authority over swaps, except for "security-based swaps," defined as swaps on a single security, which are regulated by the SEC. The CFTC and the SEC share authority over "mixed swaps," which are security-based swaps that also have a commodity component. For further details, see Acharya et al. (2010).

The Dodd-Frank Act also requires mandatory clearing through a regulated central counterparty (CCP) of all swap trades that the CFTC and the SEC determine should be cleared. As a bilateral contract, each party in a CDS contract faces the risk that the other party will not fulfill the obligations of that contract (counterparty risk). In the event of a counterparty default, the seller of protection risks the stream of coupon payments for the duration of the contract and the buyer of protection could potentially lose the full notional of the contract (assuming double default and a zero recovery rate). CCP reduces this risk, by becoming the buyer to every seller of protection and the seller to every buyer of protection, so that the only counterparty risk that market participants face in a cleared transaction is of the CCP itself. The clearinghouse is capitalized by its members, who themselves are required to be regulated and well-capitalized institutions. Each clearinghouse member contributes capital in proportion to its trading activity. If clearinghouse capital falls below the required minimum level, the remaining members are required to provide additional capital to compensate for the shortfall. This protects market participants from a default of individual counterparty failure, and diversifies risk among all members. In addition, CCPs also allow for the clearing of offsetting trades, since the coupon payments, credit event settlement and collateral management are all done with the CCP. These features all make cleared transactions more attractive than uncleared transactions to market participants.

On the other hand, central clearing comes with the requirement to post margin. In the uncleared world, collateral posting was governed by a bilaterally negotiated ISDA Master Agreement, and could vary substantially across counterparties' size and credit rating. Anecdotally, dealers in the market were rarely required to post initial margin in bilateral contracts. In contrast, in cleared transactions, the CCP determines margin and collateral requirements, providing a more standardized approach to margining. Specifically, there are two margin requirements: initial margin and variation margin. The initial margin is set to compensate for a scenario in which the counterparty defaults and fails to post the daily variation margin. It is calculated at the portfolio level, offsetting cleared positions. The variation margin compensates for the daily mark-to-market of the trade. Duffie et al. (2015) estimate the impact on collateral demand of these clearing and margin requirements under various scenarios, such as increased novation of CDS to CCPs, an increase in the number of clearing members, and the proliferation of CCPs of both specialized and non-specialized types.

Some single-name CDS and CDS indices were already cleared on a voluntary basis even prior to the passage of the Dodd-Frank Act. As the regulator of the CDS index market, the CFTC called for a phased-in mandatory central clearing for different types of market participants of most index trades over the course of 2013. The clearing requirement applies to specific tenors and series of the CDX.NA.IG and the CDX.NA.HY indices, specifically, CDX.NA.IG 5Y, series 11 and all subsequent series; CDX.NA.IG 7Y, series 8 and all subsequent series; CDX.NA.IG 10Y, series 8 and all subsequent series; and CDX.NA.HY 5Y, series 11 and all subsequent series. At the time of writing, the SEC has yet to finalize rules regarding the clearing of single-name CDS in the U.S., though some contracts are centrally cleared voluntarily.

In addition, standardized swap trades have to be executed on swap execution facilities (SEFs), the rules governing which in the U.S. were finalized on May 16, 2013 and went into effect in August 2013. In the CDS space, these include all index transactions in the CDX.NA.IG, CDX.NA.HY, iTraxx Europe, and iTraxx Europe Crossover families. The rules also define the types of trading platforms required to register as SEFs, the core principles by which they must operate and the execution methods that must be used to trade swaps. With the introduction of made-available-to-trade (MAT) on SEFs in January 2014, the current on-the-run and first off-the-run series of the five-year CDX.NA.IG, CDX.NA.HY, iTraxx Europe and iTraxx Europe Crossover have been required to trade on SEFs since February 2014.

The most recent regulatory change to swap markets is the introduction of mandatory initial margins for non-cleared positions, with the U.S. adopting mandatory initial margin rules in September 2016, and the rest of the world in March 2017. Mandatory initial margin increases the cost of bilateral trading both by requiring the dealer and not just the customer, as was the historical practice, to post margin, and by requiring a higher level of initial margin than in comparable cleared contracts. These changes provide incentives for market participants to migrate to cleared trades for clearing-eligible instruments.

3 Supervisory DTCC Data

Though CDS have been traded since 1994, the lack of detailed data on CDS transactions and positions prior to the financial crisis has limited our ability to study the decisions made by the heterogeneous participants to trade credit risk through CDS instruments.[12] Since the 2007-2009 financial crisis, detailed trade-level information has become available. In this section, we describe the available datasets and what we can learn from them.

3.1 Review of Data Used in the Literature

Despite the inherent decentralized nature of the CDS market, the Depository Trust and Clearing Corporation (the DTCC) has been collecting transaction information through its widely used lifecycle event processing service Deriv/SERV. The DTCC estimates that this service covers approximately 98% of all standard credit derivatives contracts.[13] After fi-

[12]For a comprehensive review of the literature, see Augustin et al. (2014).

[13]Comparing the gross notional of contracts reported by the DTCC and the gross notional of contracts that banks and dealers voluntarily reported in a Bank for International Settlements (BIS) survey, the ECB (2009) concludes that while the DTCC covers 98% of CDS contracts involving a dealer, it captures only 29% of contracts reported to the BIS that do not involve a dealer.

nancial crisis reforms, the DTCC has leveraged these data in two ways. One outlet is its publication of weekly statistics on volume and activity in the CDS market through the Trade Information Warehouse (TIW). The statistics include notional outstanding figures by participant type (dealer, non-dealer, central counterparty), product type (single-name, indices and index tranches), term, and currency since the November 2008. Oehmke and Zawadowski (2016) exploit a subset of these data – total net notional amount of CDS protection written on the top 1,000 single-name reference entities – to investigate participants' objectives for trading in the CDS market.

The DTCC also provides global regulators a more granular view of the market by providing transactions- and positions-level data. The transactions-level data include new trades, assignments (aka novations), and terminations. For each record, the DTCC data contain the following information: names of the protection buyer and protection seller, submitter of the transaction to the DTCC, reference entity, trade date, termination date, notional amount, and currency. The DTCC provides different subsets of the worldwide dataset to different jurisdictions, supporting the relevant authorities' mandates for regulating and supervising OTC derivatives markets and market participants.[14]

Chen et al. (2011) examine a three-month sample of global single-name CDS (corporate, sovereign, muni, ABS and loan CDS) and index CDS transactions to evaluate the market's size and composition, the frequency of trading activity and the level of standardization of CDS products, prior to the introduction of post-trade public reporting to the CDS market. Their sample comprises all CDS transactions occurring globally between May 1 and July 31, 2010, where at least one G14 dealer was a counterparty to the trade. Shachar (2013) analyzes transactions in single-name CDS contracts on 35 financial firms, as well as transactions in CDX Index contracts. The sample includes all CDS transactions occurring between February 2007 and June 2009, regardless of the counterparty region. The exact identity of the counterparties is masked, but the type of the counterparty is provided. Using these data,

[14]See BIS (2013) for a consultative report on authorities' access to centralized trade repository data.

Shachar (2013) shows that bilateral exposures in the interdealer market, as a proxy for counterparty risk, are empirically relevant in the determination of the intermediation capacity of dealers and in the resilience of the market during times of stress. Using a methodology similar to that of Shachar (2013), Gehde-Trapp et al. (2015) use single-name CDS with German firms as the reference entities from January 2009 to June 2011, and show that CDS premia reflect market frictions rather than the credit risk of the underlying reference entity. Du et al. (2015) observe CDS transactions from January 2010 through December 2013 in which at least one of the dealer banks regulated by the Federal Reserve Board (FRB) is a counterparty to the trade or is the reference entity itself. The FRB-regulated institutions are: Bank of America, Citibank, Goldman Sachs, JP Morgan Chase, and Morgan Stanley. They focus on how counterparty risk is priced and managed by market participants. Siriwardane (Forthcoming) uses a granular DTCC dataset that includes full identities of counterparties, terms of trade, and (nearly) all outstanding CDS exposures for all transactions that reference North American entities and/or U.S. participants, starting in 2010. Using the same dataset, Eisfeldt et al. (2018) study to what extent dealers exert pricing power in the market for index CDS, and find that credit spreads in dealer-to-dealer trades are 6% lower than credit spreads in dealer-to-customer trades.

The "supervisory" the DTCC datasets aside, a few papers exploit other versions of the DTCC data or other data sources. Duffie et al. (2015) obtain a version of the DTCC data not through supervisory authority, so their dataset encompasses gross and net bilateral exposures between any two counterparties for 184 single-name CDS (9 G20 sovereigns, 20 European sovereigns, and 155 global financial entities), without any restriction on the counterparties' origin. Yet, their dataset does not contain the identity of the counterparties, the date at which a particular trade was executed, or the maturity of each position. Loon and Zhong (2016) use publicly disseminated Index CDS transactions. As we mentioned in Section 2, since December 31, 2012, index CDS transactions have to be reported to an SDR, which in turn publicly disseminates transaction details, including price, size, and time. Loon and

Zhong (2016) collected CDS Index transactions that were executed between December 31, 2012 and December 31, 2013 from the DTCC data repository. They merge these transactions with the intra-day and end-of-day quotes to calculate the transaction-level relative effective spread and other liquidity measures. Tang and Yan (2017) use transactions data from the GFI Group from January 1, 2002 to April 30, 2009, and argue that CDS spreads not only change in response to fundamentals but also in response to supply-demand imbalances and liquidity in the market. Arora et al. (2012) use a proprietary dataset from one of the largest fixed-income asset management firms, which contains both actual CDS transaction prices for contracts entered into by this firm as well as actionable quotations provided to the firm by a variety of CDS dealers. Their data cover the period of March 2008 to January 2009.

More recently, transactions data from SEFs have become available. Collin-Dufresne et al. (2017) collect transactions data for multiple dealer-to-dealer and dealer-to-client SEFs for the period from October 2, 2013 to October 16, 2015, and find that average transaction costs are higher for dealer-to-client trades. Using message-level data for May 2016 for two dealer-to-client SEFs, Riggs et al. (2017) find that customers contact fewer dealers if the trade size is larger or non-standard, while dealers are more likely to respond to customers' inquiries if fewer dealers are involved in competition, if the notional size is larger, or if more dealers are making markets.

Although the papers use data on different parts of the network of CDS exposures, a consistent picture emerges. First, credit exposures fluctuate over time, and institutions that are net sellers of credit protection in one period can become net buyers of protection in another. Second, the pricing of the exposure traded depends on the counterparties to the trade, though the literature has yet to converge to a consensus on whether and to what extent dealers are able to exert market power in this market, as well as the effect that the introduction of mandatory clearing has on the pricing strategies of the other participants in this market.

3.2 Our Data

Our version of the DTCC data is obtained through the supervisory authority of the Federal Reserve System. Each weekly snapshot reports all outstanding CDS positions as of the report date in which at least one of the dealer banks regulated by the Federal Reserve Board (FRB) is a counterparty to the trade or the reference entity itself. We refer to this subset of all the CDS trades collected by the DTCC as "supervisory DTCC."

For the positions that the DTCC reports to the Federal Reserve, we observe detailed contractual terms, including the identities of the counterparties to the trade, the pricing terms (both the fixed spread and the upfront payment), the notional amount of the contract, the trade date, maturity and restructuring clause. The sample period used in this paper is January 2010 through June 2019, representing 497 observation weeks, 12,971,160 unique contracts, 3,427 unique reference entities,[15] 13,474 unique buyers of protection and 12,555 unique sellers of protection. In a median week, 22,212 new positions are opened, corresponding to 829 unique reference entities, with exposures exchanged between 752 unique buyers and 766 unique sellers.

Although these data cover only a subset of the overall transactions in the CDS market and thus have inherent limitations, the six institutions for which we observe all open positions on a report date are large participants in the market. Comparing the positions observed in our data to the total market activity captured by the DTCC TIW, we find that the positions of the six supervised institutions account, on average, for 70% of the total activity in single-name derivatives, 58% of the activity in index products, and 91% of the activity in index tranche products, as measured by the number of contracts, and gross notionals (see Figure 3). Thus, although the supervisory DTCC data are limited to transactions involving the six supervised institutions, they do cover a large fraction of the overall CDS

[15] An index type (e.g., CDX.NA.IG) is counted as a single reference entity, regardless of the series and version.

market. Figures 3 and 4 present summary statistics on the number of contracts and gross notionals for different subsamples of the supervisory DTCC data. Overall, we find that the supervisory DTCC data are a representative subsample of the aggregate TIW data, capturing a substantial fraction of the aggregate activity (between 50 and 95%, depending on the instrument) in the market.

Overall activity We begin by examining the overall activity in the market for the three types of CDS instruments: single-name, index and index tranche. The top two panels of Figure 3 present the distribution of the gross notional amount outstanding in U.S. dollar billion equivalents and the number of contracts in thousands for the DTCC TIW, while the bottom two panels report the fraction of the total reported in the supervisory DTCC data.

Consider first the quantities reported in the DTCC TIW. Over our sample period, both the gross notional and the number of contracts outstanding for single-name contracts have been declining steadily, driving the overall decrease in the gross notional and contracts outstanding for the market. The significant decline is partly attributed to compressions activity, when redundant contracts on the same reference entity are terminated and replaced by new ones with the same net exposure. The gross notional outstanding for index and tranched index contracts has also declined somewhat since 2010, though not to the same extent as in the single-name market. Interestingly, while the number of contracts traded is much larger for the single-name contracts than for index trades, the gross notionals are comparable for these types of trades. That is, while contracts using single-name reference entities are more frequent, the notional amount of a contract written on a single-name reference entity is much smaller than the notional amount of a contract written on an index.

Consider now the coverage in the supervisory DTCC data, reported as%age covered of the corresponding the DTCC TIW data. We see that, in aggregate (that is, considering all three types of contracts jointly), in an average reporting week, the supervisory data capture 60% of the gross notional outstanding and 62% of the number of contracts. The supervisory DTCC sample has the lowest coverage for index trades. This is not surprising as the index provides a more diversified credit risk exposure, and the trading of index products was standardized prior to the start of our sample; therefore, the identity of the seller of protection is less detrimental to the value of the contract. Moreover, index CDS trades frequently occur with a CCP as a party to the trade. Nonetheless, for an average week in the sample, the supervisory data capture 55% of the number of contracts and 57% of gross notional traded in index products. For single-name trades, the supervisory data capture around 69% of the number of contracts traded and 67% of the gross notional in an average week. Finally, the supervisory sample captures a large fraction of the overall activity in index tranche trades, as evidenced by both the number of contracts and the gross notional traded: for an average week in the sample, the supervisory DTCC data capture 90% of the number of contracts traded and 93% of the gross notional.

Trading by type of counterparty In our sample, 7,493,715 contracts are exchanged between dealers, 1,968,379 contracts are exchanged between dealers and their customers, and 2,858,924 are exchanged between a dealer and a CCP. In a median week, 9,892 contracts are exchanged between dealers, 3,657 between dealers and their customers, and 5,417 between a dealer and a CCP. Figure 4 shows the average number of contracts and gross notionals exchanged between different types of market participants by product category. We use the DTCC classification to designate institutions as dealers, non-dealers (customers) and CCPs. Overall, the supervisory DTCC data cover a large fraction of dealer-to-dealer and dealer-to-customer trades (83% and 58% in terms of the number of contracts and 82% and 55% in terms of gross notional, respectively). The coverage of dealer-to-CCP trades is somewhat lower: the supervisory data cover approximately 48% of the number of contracts and 55% of the gross notional of the trades between CCPs and dealers.[16] This relatively low coverage

[16]The TIW also reports the number of contracts and gross notional for customer-to-customer and customer-to-CCP trades. Since the supervisory DTCC data do not cover these trades, we omit them from Figure 4.

of trades between CCPs and dealers explains the relatively low coverage of index trades and the relatively high coverage of index tranche trades (since index tranche positions cannot be traded with a CCP). Indeed, Figure 4c and Figure 4d show that while the supervisory data capture a large fraction of dealer-to-dealer index trades (around 75% in terms of the number of contracts), it captures only slightly more than a quarter of the index contracts exchanged between a dealer and a CCP.[17] Combined with the relatively good coverage of transactions between dealers and non-dealers in the single-name market, this suggests that non-dealer participants prefer to use index contracts to take on exposure to credit risk.

4 Aggregate Activity in the Market

4.1 Metrics of Activity

We begin by looking at financial institutions' weekly activity in each segment of the CDS market. For each weekly snapshot, we compute each participant's buy- and sell-side positions in single-name, index, tranche and option products, as well as the corresponding net positions. The net position is equal to the difference between the buy and sell positions for each underlying, with a positive position indicating that the institution is, on net, buying protection. Formally, participant p's position in contracts on reference entity i with maturity τ at snapshot date h is the sum of notionals in contracts in which p is the buyer of protection less the sum of notionals in contracts in which p is the seller of protection

$$\text{Net Position}_{p,i,\tau,t} = \text{Notional bought}_{p,i,\tau,t} - \text{Notional sold}_{p,i,\tau,t}.$$

We construct two measures of market activity: gross and net notional. *Gross notional* sums the par amount of credit protection bought (or, equivalently, sold) in all the contracts

[17] This represents, however, 45% of the gross notional of index contracts exchanged between a dealer and a CCP.

counted by the number of contracts. *Net notional* sums the net positions of all the participants that are, on net, buying protection (or, equivalently, selling protection). In terms of the notation above, these two concepts of notional for reference entity i on date t are defined as

$$\text{Gross notional}_{it} = \sum_{p,\tau} \text{Notional bought}_{p,i,\tau,t}$$

$$\text{Net notional}_{it} = \sum_{p} \left(\sum_{\tau} \text{Net position}_{p,i,\tau,t} \right) \mathbf{1} \left(\sum_{\tau} \text{Net position}_{p,i,\tau,t} > 0 \right).$$

Net notional positions represent the maximum possible net transfer between sellers and buyers of protection in case of a credit event for the reference entity; when the recovery rate at the time of the credit event is above 0, the actual funds transferred are a fraction (equal to one less the recovery rate) of the net notional. Gross notional, on the other hand, measures the total volume of transactions in the CDS market. An important caveat of summarizing the activity in the CDS market using these measures is that they are based on the face value of the contract and thus do not reflect the market value of the contracts nor the duration of the contracts. Thus, neither gross nor net notional captures the economic exposure of market participants to credit events. In the online appendix we further show that, overall, the qualitative properties of the duration-risk-adjusted positions are similar to those of the raw positions. We thus focus on the unadjusted gross and net notionals in the main body of the paper.

4.2 Sample Selection

We start with the DTCC positions dataset, which represents 12,971,160 contracts on 3,427 reference entities between 13,474 buyers and 12,555 sellers. To ameliorate the effect of reporting requirements, we use only contracts entered into between January 2010 and June 2019, written on U.S. and Advanced European corporate reference entities that are either single-name, index, index tranche or index option contracts. Table 1a summarizes how the original sample changes with each filter applied. The details of the overall sample construction and of the splits by characteristics used below are described in the online appendix.

4.3 Characteristics of Outstanding Positions

We begin by examining the characteristics of all positions outstanding as of a given snapshot date. The outstanding positions represent the longer-term trends in the market, capturing gradual changes in exposures, and provide an overview of the total exposures as of a given point in time. Figures 5–9 plot monthly average gross and net notional of outstanding positions by counterparty type, counterparty location, on-the-run index membership, clearing eligibility, and master agreement type.

Positions by counterparty type Figure 5 plots the gross and net notional exposure in single-name, index, index tranche and index option of dealers, non-dealer customers ("buy-side" counterparties), and CCPs. Consider first the exposures in the index tranches and options, plotted in the bottom two rows. The figure shows that while index options are a relatively new type of contract, their prominence has been growing over time, replacing index tranches as the preferred levered position on the index. In both index tranches and options, dealers are historically the buyers of protection from buyside counterparties. The only exception is the period from January 2012 to mid-2013 when dealers were selling protection to buyside counterparties in the index tranche market. Comparing the gross and net exposures, we see that dealers also exchange a large fraction of the total index tranche gross notional between each other.

Turning next to the single-name exposures, plotted in the top row of Figure 5, we see that dealers once again exchange a large volume of gross notional with each other but, unlike with the levered products, dealers are net sellers of protection throughout our sample, while buyside counterparties are net buyers of protection. Despite an increased number of single-name contracts eligible for clearing over time, CCPs do not appear to have increased their gross exposure to single-name contracts, and oscillate between being net sellers and net buyers of protection. Overall, both the gross and net exposures taken through the single-name market have declined over time, consistent with the global trend seen in Figure 3.

In contrast, while we see some decreases in the gross notional in index contracts prior to January 2014 (plotted in the second row in Figure 5), the net notional traded has remained mostly constant in our sample period. While dealers were primarily net sellers of protection in the index CDS market until mid-2014, they have become net buyers of protection from buyside counterparties (primarily) and CCPs (to a smaller extent).

Positions by counterparty location Consider now credit exposures traded across jurisdictions, plotted in Figure 6. Across all four CDS products, the largest fraction of gross notional is traded between counterparties in the same jurisdiction, while gross notional exposure to counterparties based outside the U.S. and advanced economy European countries is negligible. Turning to the net positions, we see that U.S. counterparties are primarily net buyers of protection in the index tranche market, net sellers of protection in the index and index option markets, and oscillate between being net buyers and net sellers of protection in the single-name market. In the index and index tranche market, their primary counterparties are based in European jurisdictions. While European counterparties also represent a sizable fraction of net notional traded in the single-name market prior to January 2016, more recently, institutions based outside of the U.S., Europe, and Japan have been buyers of protection from U.S. and Europe-based counterparties. In the index option market, these "rest-of-the-world" institutions have been the principal buyers of protection since January 2013, with European counterparties switching between being net buyers and net sellers of protection in that market.

On-the-run vs off-the-run positions The last regular feature of outstanding positions that we study is the membership in an on-the-run series of an index, plotted in Figure 7. Recall that an index series is considered on-the-run if it is the latest series (and version) of the index as of a given date. For single-name reference entities, we separate four cases: the single-name belongs only to the on-the-run series of an index, to only the off-the-run series, to both the on-the-run and off-the-run series, and does not belong to an index. In both gross and net notional terms, the majority of single exposure is traded in contracts that belong to both the on-the-run and off-the-run series and very little in the on-the-run only category, reflecting the slow pace of the replacement of membership in the indices. Single-names that do not belong to any index also represent a sizable fraction of gross and net notional traded, though their prominence has been declining over time. In the index market, the on-the-run indices represent about a fifth of the gross notional outstanding but nearly half of the net notional bought. In contrast, index tranche exposures are almost exclusively in tranches written on the off-the-run series, while index option exposures are primarily in options written on the on-the-run series. As we will see in Figure 11, this happens because index options have short maturities – less than one year – so that the option market can adapt quickly to the introduction of new index series.

Positions by clearing eligibility We now study how outstanding positions change in response to two market changes: the introduction of central clearing and the adoption of the ISDA 2014 Master Agreement. Figure 8 plots the gross and net notional traded by clearing eligibility – that is, whether a contract is eligible for clearing on a CCP, rather than whether the contract was actually cleared. For index tranches and options, "clearing eligibility" indicates that the contract is written on an index eligible for clearing, rather than the contract itself being accepted for clearing on a CCP. In the single-name market, as more reference entities have gradually become eligible for clearing, both the gross and net notional of clearing-eligible contracts have increased, with the decrease in the overall gross notional of single-name contracts traded driven by the segment of the market that is not eligible for clearing. With the introduction of mandatory central clearing for index contracts in the U.S. in March 2013, both gross and net notional outstanding in index, index tranche and index option contracts migrated quickly to clearing-eligible series of the index. Overall, Figure 8 suggests that, as increasingly more single-name reference entities become accepted for clearing on CCPs, market activity will increasingly be conducted in clearing-eligible contracts, even without mandatory clearing rules in the single-name market.

Positions by master agreement type Figure 9 plots the gross and net notional outstanding by ISDA Master Agreement. As with the introduction of mandatory clearing for index products, outstanding positions in single-name, index and index option products transitioned quickly to the ISDA 2014 Master Agreement, with contracts with the new Master Agreement representing the majority of both gross and net notional outstanding within six months of the agreement going "live" in October 2014. The index tranche market has, however, responded more sluggishly, with ISDA 2003 contracts representing at least 50% of gross notional outstanding as late as January 2017.

4.4 Characteristics of New Positions

We now turn to the characteristics of the new positions entered into as of a given snapshot date. We identify new contracts as the first occurrence of a contract for which the effective date is reported to be after the trade date. New positions provide an overview of the risks traded by participants in the market at a weekly frequency, capturing faster-changing features of the market than outstanding positions do. Figures 10–13 plot the net notional of new positions by credit rating of the underlying reference entity, initial maturity of the contract, reference entity sector, and currency of the contract, together with the percent of new gross notional traded represented by each category.

Trading by credit rating We begin by examining the distribution of credit ratings of the underlying reference entities, plotted in Figure 10. For both single-name and index products, the majority of new gross notional is traded in the investment grade category. iTraxx Europe Crossover (the "unrated" category for index products) represents around 10% of new gross notional traded, and, interestingly, only has index options, not index tranches traded. More generally, index tranche net notional is almost exclusively traded in the investment grade category, though tranche contracts written on high yield indices represent around 20% of new gross notional traded in the later half of our sample.

For single-name reference entities, we can further break the investment grade category down into the AAA, {AA,A} and BBB categories. From the top row of Figure 10, we see that around 40% of new gross notional is traded in the BBB category, around 20% is traded in the {AA,A}, and a negligible amount is traded in the AAA category. Contracts on BBB-rated reference entities also represent the majority of new net notional exchanged. This ranking of the relative sizes of CDS traded exposures to reference entities with different credit ratings corresponds to the ranking of the relative amounts outstanding of debt issued: the majority of debt issuance in the U.S. after the financial crisis has been in the BBB credit rating, while only two AAA firms remain in the U.S.[18]

Trading by maturity Figure 11 plots the distribution of new gross and net notional traded by the initial maturity of the contract. Three striking features emerge. First, as we noted earlier, index options have exclusively short maturities. This likely reflects the semi-annual roll of the index contract; indeed, in unreported results, we investigate the maturity of index option contracts in more detail and find that the overwhelming majority of contracts have an initial maturity of less than six months. Second, while index and index

[18] As of July 2018, total outstanding of BBB-rated corporate bonds was $2.56 trillion, $2.55 trillion of bonds rated higher than BBB, and $1.21 trillion of high-yield bonds. Source: Bloomberg Opinion, "The Corporate Bond Market is Getting Junkier," July 10, 2018, https://www.bloomberg.com/opinion/articles/2018-07-10/corporate-bonds-are-getting-junkier.

tranche contracts are increasingly traded in the five-year maturity category, the distribution of maturities traded in the single-name market is less concentrated, with 20-30% of gross notional traded in the five-year category, around 60% of gross notional traded in the between one-to-five-year category, and a further 10-20% of gross notional traded in the one year or below initial maturity. Thus, a substantial fraction of transactions in the single-name market are done with maturities of less than five years. Finally, while historically index and index tranche contracts had a non-negligible fraction of gross notional traded with maturities of 10 years and greater (as much as 15% for index contracts; 50% for index tranche contracts), these longer maturities were never prevalent in the single-name market. Thus, while market participants were historically willing to trade long-term exposures to index contracts, the single-name market has always been concentrated in intermediate maturities.

Trading by reference entity sector Examining the single-name market in greater detail, Figure 12 plots the distribution of exposure trade by industry of the reference entity. Contracts written on manufacturing (around 25% of new gross notional traded) and financial firms (around 20% of new gross notional traded) are the most prevalent in the market, with contracts on energy firms increasing in popularity starting in January 2015. Energy firms, however, still represent a negligible fraction of the net notional traded, with the majority of net notional traded concentrated once again in manufacturing and financial firms.

Trading by currency Finally, Figure 13 shows that both new gross and new net notionals in contracts on U.S. and European reference entities are split between contracts denominated in U.S. dollars and euros, with hardly any notional exchanged in other currencies. Euro-denominated index contracts have been slowly becoming more common: around 30% of new gross notional traded was denominated in euros in January 2010 but around 50% of new gross notional traded was denominated in euros in June 2019. The single-name market, however, remains predominantly denominated in U.S. dollars, creating a potential currency mis-match between the single-name and index markets.

5 Dealers and CDS Pricing

In the previous section, we studied the characteristics of the existing and new positions in the market for corporate CDS in the U.S. and Europe. We now turn to the pricing of these transactions, focusing on whether dealers face different transaction prices when they are transacting with other dealers than when they are transacting with non-dealer customers.[19]

5.1 Sample Selection and Regression Specification

We start with the DTCC transactions data set, which represents 15,596,566 transactions on 3,276 reference entities between 14,487 buyers and 13,713 sellers. In a median week, 10,369 unique contracts are exchanged between dealers, 4,161 between dealers and their clients, and 7,950 between a dealer and a CCP. As with the positions data, we focus on transactions entered into between January 2010 and June 2019, and written on U.S. and Advanced European corporate reference entities, but we focus on transactions in the single-name and index contracts with five-year maturity only. We use confirmed transactions, with "trade" transaction type, and market risk indicator equal to "yes."[20] Finally, we select transactions with ISDA 2003 Master Agreement prior to October 2014, and with ISDA 2014 Master Agreement afterward. We only use contracts with no restructuring (XR or XR14) for contracts on U.S. reference entities, and contracts with restructuring (MR or MR14) for contracts on European reference entities, denominated in local (with respect to the reference

[19] Studies of related markets have found that more central network participants tend to receive advantageous pricing terms when transacting with less central counterparties. Di Maggio et al. (2017) find that this is the case for purchases of corporate bonds between core and periphery dealers in the TRACE network. Li and Schürhoff (Forthcoming) document that, while more central dealers in the municipal bond market provide immediacy, trading costs increase strongly with dealer centrality.

[20] The market risk indicator flags transactions that result in a change in the market risk position of the market participants and are market activity. By imposing the condition that market risk indicator equals "Y," we exclude, for example, central counterparty clearing and portfolio compressions.

entity) currency. Table 1b summarizes how the original sample changes with each filter applied. The details of the sample construction are described in the online appendix.

Table 2a reports the number of transactions with the above filters applied across different fixed rates. In the United States, single-name investment grade reference entities primarily trade with a fixed rate of 100 bps, representing 5% of total gross notional traded in contracts on U.S. reference entities (Table 2b), though a small fraction also trade with a fixed rate of 500 bps. Similarly, single-name high-yield reference entities primarily trade with a fixed rate of 500 bps, representing 1.6% of total gross notional traded in the U.S. Finally, the investment-grade index trades almost exclusively with a fixed rate of 100 bps, representing 68.7% of gross notional traded, and the high-yield index trades almost exclusively with a fixed rate of 500 bps, representing 18.5% of gross notional traded. Thus, in the U.S., both of the standard fixed rates are used, with contracts on investment-grade reference entities primarily trading with fixed spreads of 100 bps and contracts on high-yield reference entities primarily trading with fixed spreads of 500 bps.

The same patterns hold for contracts on European reference entities. Single-name investment grade reference entities primarily trade with a fixed rate of 100 bps, representing 3.2% of total gross notional traded in contracts on European reference entities, though a small fraction also trade with a fixed rate of 500 bps. Similarly, single-name high-yield reference entities primarily trade with a fixed rate of 500 bps, representing 0.8% of total gross notional traded. iTraxx Europe trades almost exclusively with a fixed rate of 100 bps, representing 73.4% of gross notional traded, and iTraxx Europe Crossover trades almost exclusively with a fixed rate of 500 bps, representing 18.8% of gross notional traded. Surprisingly, even though contracts with fixed rates of 25 bps, 300 bps and 1000 bps are also standard for European reference entities, very few transactions are conducted at these rates.

Given this distribution of fixed rates in both the U.S. and Europe, we focus on contracts with fixed rates of either 100 or 500 bps. We convert the stated fixed spread and upfront on each contract to an equivalent running spread using the ISDA Standard Converter.[21] The ISDA Standard Converter operates under several standard assumptions. It assumes that the accrued premium is not paid upon default, and imputes a constant, non-negative hazard rate throughout the credit curve. To construct the discount curve, the converter uses swap and deposit rates to derive piece-wise constant instantaneous forward rates.

Following Collin-Dufresne et al. (2017), we define the transaction cost of a contract on date t, reference entity i between buyer b and seller s as the absolute difference between the equivalent running spread on the contract and the quoted Markit spread for reference entity i on date t:

$$\text{Trans. cost}_{i,t,b,s} \equiv \left|\text{Spread}_{i,t,b,s} - \text{Markit spread}_{i,t}\right|.$$

Subtracting the quoted Markit spread effectively controls for the overall state of the market for reference entity i on date t. Table 3 reports the mean and standard deviation of transaction costs for contracts with fixed rates of 100 bps and 500 bps. Overall, contracts with 500 bps have higher average transaction costs than contracts with 100 bps. Comparing single-name and index contracts, single-name contracts on U. S. reference entities tend to have lower average transaction costs than index contracts with comparable credit ratings, while single-name contracts on European reference entities have higher average transaction costs than index contracts with comparable credit ratings.

Our main focus in this section is how transaction costs change across buyer and seller types, clearing eligibility of the reference entity, industry (for single-name CDS), and on-the-

[21] We use the source code for the par-equivalent CDS spread calculation from Markit's website.

run classification. In particular, we estimate the following regression:

$$\begin{aligned}\text{Trans. cost}_{i,t,b,s} = {} & \beta_C \mathbb{1}_{\text{Clearing},i,t} + \beta_{OFR} \mathbb{1}_{\text{OFR},i,t} + \sum_{k=1}^{5} \beta_{k,Ind} \text{Industry}_{i,t} \\ & + \beta_{IG} \mathbb{1}_{Inv.grade,i,t} + \sum_{k=1}^{7} \beta_{k,BS} \text{Buyer type}_{b,t} \times \text{Seller type}_{b,t} \\ & + \sum_{k=1}^{7} \beta_{k,C,BS} \text{Buyer type}_{b,t} \times \text{Seller type}_{b,t} \times \mathbb{1}_{\text{Clearing},i,t} \\ & + \alpha_t + \alpha_i + \alpha_{it} + \epsilon_{i,t,b,s},\end{aligned} \tag{2}$$

where $\mathbb{1}_{\text{Clearing},i,t}$ is an indicator equal to 1 if the reference entity i is accepted for clearing at date t, and buyer (seller) type is a dummy for the buyer (seller) being a dealer, CCP, or non-dealer customer, as classified by the DTCC. Positive estimated coefficients correspond to higher transaction costs. For example, a positive coefficient β_C on the clearing eligibility indicator would indicate that transactions referencing entities that are eligible for clearing have higher transaction costs. In some specification, we also include reference entity and reference-entity-week fixed effects, in which case we remove the industry dummies from the regression. We estimate the specification (2) separately for each market (U.S. and Europe), each contract type (single-name and index), and each level of fixed spread (100 and 500 bps).

5.2 Transaction Costs in the Single-Name Market

Table 4 reports the estimated coefficients from the regression (2) for single-name CDS contracts on U.S. and European corporate reference entities. Consider first single-name contracts written on U.S. reference entities (columns 1–4). Transaction costs are lower for investment-grade reference entities, for larger transactions, and when dealers are buying protection from customers. Transaction costs are higher for single names included only in an on-the-run series of the index, written on reference entities outside the manufacturing industry, and, for contracts trading with 100 basis point (bps) fixed spread, when customers are buying protection from dealers. That is, dealers in the market for U.S. single-name reference entities are able to exert market power both by paying lower transaction costs when buying protection from customers and by earning higher transaction costs when selling protection to customers. These effects are both statistically and economically significant: relative to the average transaction cost of 3.85 bps for contracts trading with a fixed rate of 100 bps, dealers are able to charge 1.81 bps more when selling protection to customers, and pay 0.78 bps less when buying protection from customers. Similarly, relative to the average transaction cost of 31 bps for contracts trading with a fixed rate of 500 bps, dealers are able to pay 5.6 bps less when buying protection from customers but charge 4 bps less when selling protection to customers.

Clearing eligibility reduces the average transaction costs for contracts trading with fixed rate of 500 bps, reduces the pricing concessions that dealers get when buying protection from buyside customers, but increases the surcharge that dealers charge when selling protection to customers. When we include reference entity and reference-entity-week fixed effects, however, we see that clearing-eligibility no longer affects transaction costs for contracts trading with fixed rate of 500 bps. Instead, average transaction costs for contracts trading with fixed rate of 100 bps are 2.4 bps lower, and dealers are able to charge 0.40 bps more when selling protection to customers on clearing-eligible reference entities.

Consider now the transaction costs in the European single-name market (columns 5–8). Unlike in the U.S. single-name market, contracts written on investment-grade reference entities do not consistently have lower transaction costs than contracts written on high-yield reference entities. Also, unlike the market for single-name contracts on U.S. reference entities, transaction costs are higher for reference entities in the financial services industry, and lower for reference entities in the utility and telecommunications industry.

Turning next to the effect of clearing eligibility on transaction costs in this market, we see that on average, clearing eligibility increases the average transaction costs in the European single name market but reduces the surcharge that dealers charge when selling protection to customers. For contracts with a fixed spread of 100 bps, clearing eligibility increases the discount earned by dealers when buying protection from customers.

5.3 Transaction Costs in the Index Market

Consider finally transaction costs in the index market (Table 5). For CDX.NA.IG, average transaction costs are 0.78 bps lower for on-the-run series of the index but not meaningfully different for clearing-eligible series of the index. In contrast, for CDX.NA.HY, average transaction costs are 3.4 bps lower for clearing-eligible series of the index but 4.13 bps higher for the on-the-run series. For both index families, dealers pay higher transaction costs when buying protection from customers and earn higher transaction costs when selling protection to customers. Clearing eligibility drives the dealers' surcharge to zero when buying from customers and roughly halves the premium when selling to customers.

Clearing eligibility reduces average transaction costs for both iTraxx Europe (by 1 bps) and iTraxx Europe Crossover (by 12.5 bps) contracts, but the on-the-run series of the two index families have higher transaction costs than off-the-run series. In addition, clearing eligibility drives the dealers' surcharge to zero when buying from customers and roughly halves the premium when selling to customers.

6 Conclusion

OTC markets have been subject to much regulatory reform in the wake of the 2007-2009 financial crisis. In this paper, we examine the overall characteristics of the CDS market in the current regulatory environment. Our results suggest that outstanding positions react quickly to changes in the environment, with, for example, widespread adoption of the ISDA 2014 Master Agreement within six months of its introduction into the market. Despite the lack of mandatory central clearing regulation in the U.S. for single-name CDS contracts, market activity has been transitioning to clearing-eligible products, with the overall decrease in the gross notional of single-name contracts outstanding accounted for almost exclusively by reductions in the non-clearing-eligible sector of the market.

Clearing eligibility, however, does not have a consistent effect on the transaction costs in the CDS market. While we find some evidence that clearing-eligible single-name contracts in the U.S. have lower transaction costs than their non-clearing-eligible counterparts and dealers are less able to exert market power when selling protection to buyside customers, average transaction costs for single-name contracts on lower-rated European reference entities increase after the contracts become eligible for clearing on a CCP. Across all these markets, dealers are able to exert market power when trading with customers by both paying lower transaction costs when buying protection from customers and charging higher transaction costs when selling protection to customers. Clearing eligibility reduces but does not completely undo dealers' market power, except in the market for European indices.

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Figure 1. Relation between single-name CDS contracts, index contracts, and index tranches. The relatopnship between single-name CDS, index, and index tranches contracts is illustrated using the CDX.NA.HY index as an example. The CDX.NA.HY includes 100 North American reference entities with a high-yield rating.

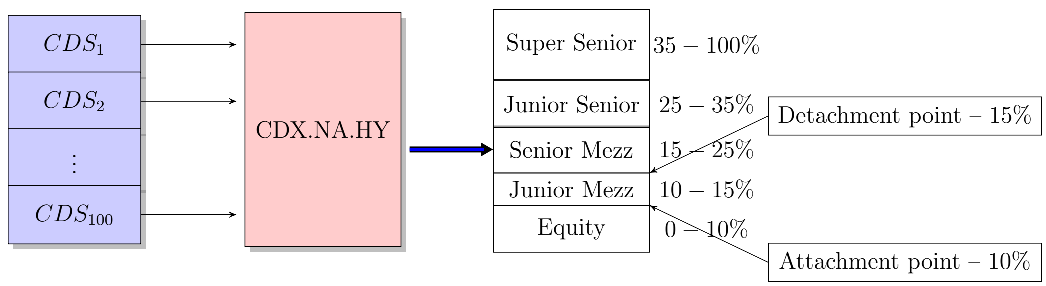


Figure 2. Timeline of CDS market evolution. Timeline of major changes affecting the CDS market in the U.S.

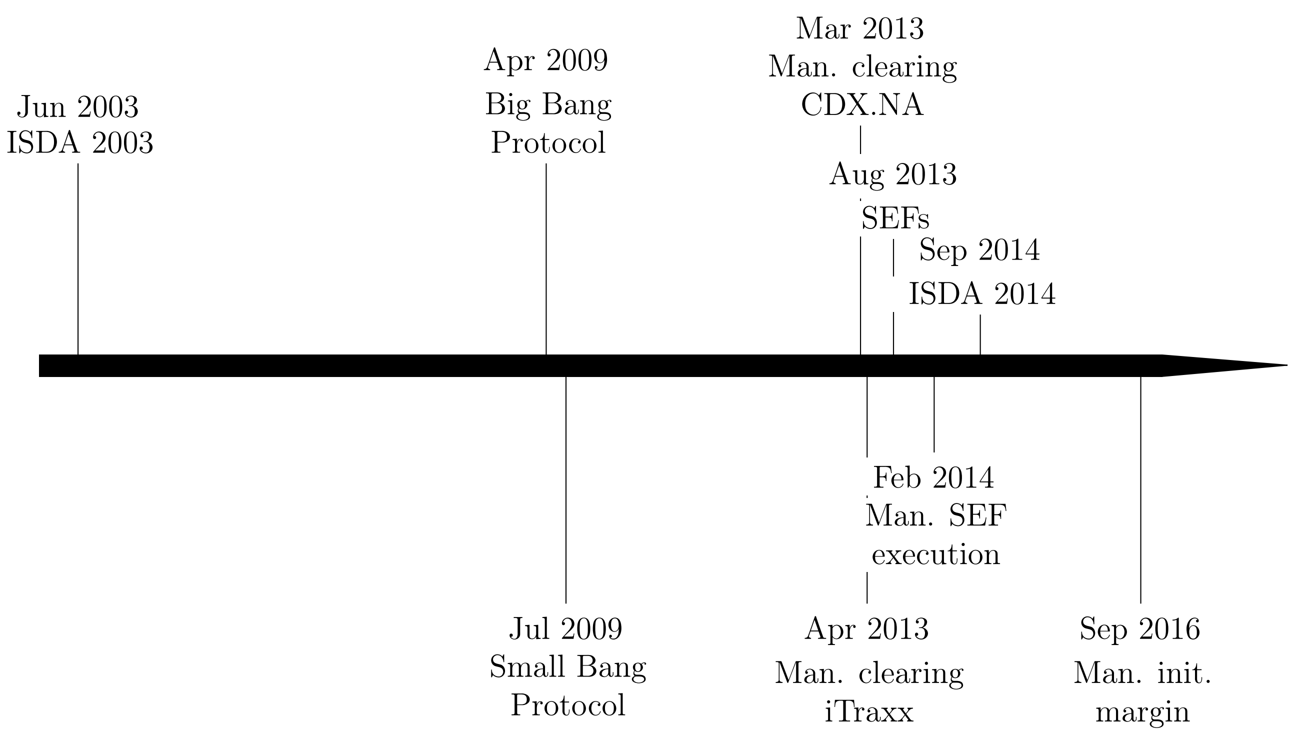
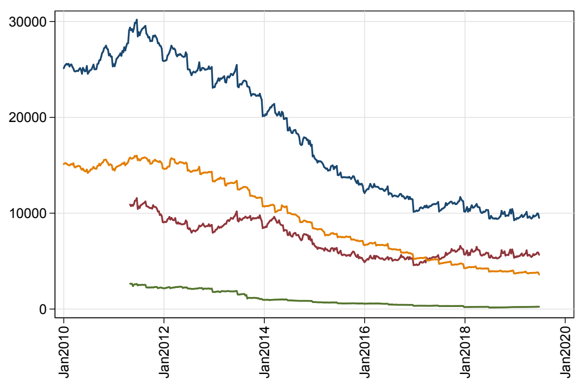
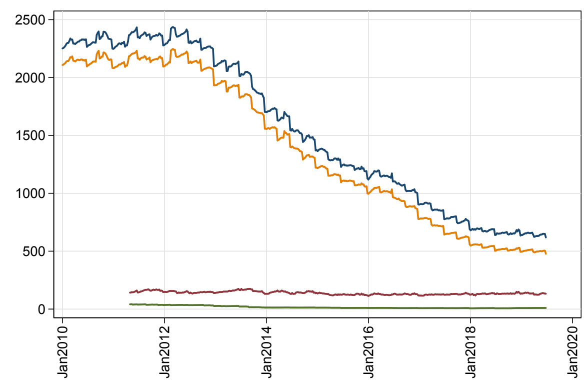


Figure 3. Worldwide CDS positions and coverage in supervisory DTCC data. Worldwide CDS positions from DTCC trade information warehouse (TIW). Number of contracts reported in thousands; notionals in USD billions. Coverage reported as the ratio between the corresponding quantities in the supervisory DTCC data and TIW data (in percentage terms).

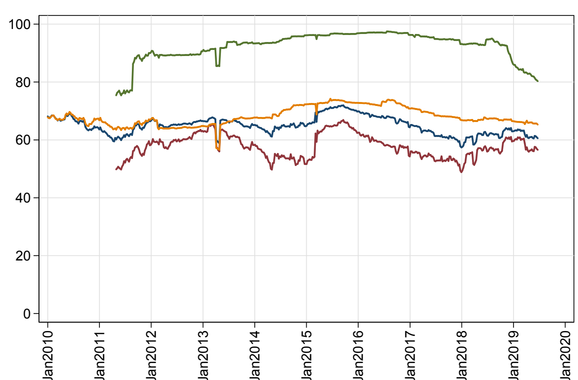
(a) Gross notional in TIW



(b) Contracts in TIW



(c) Gross notional coverage



(d) Contracts coverage

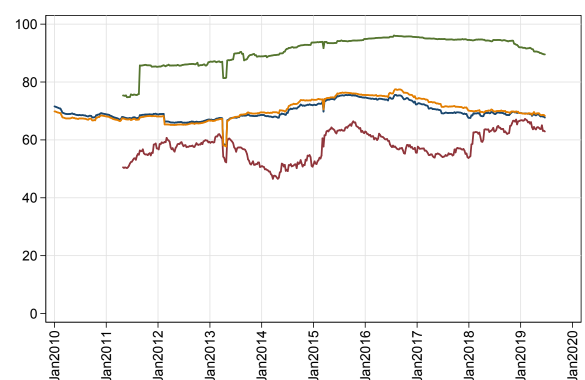


Figure 4. Comparison between supervisory DTCC and TIW data by participant type. Coverage reported as the ratio (in percentage terms) between gross notional in the supervisory DTCC data and gross notional in TIW data (left column), and the ratio between number of contracts in the supervisory DTCC data and TIW data (right column). The blue line (D-D) represents the coverage of dealer-to-dealer activity, the red line (D-C) represents the coverage of dealer-to-non-dealer activity, and the green line (D-CCP) represents the coverage of dealer-to-CCP activity.

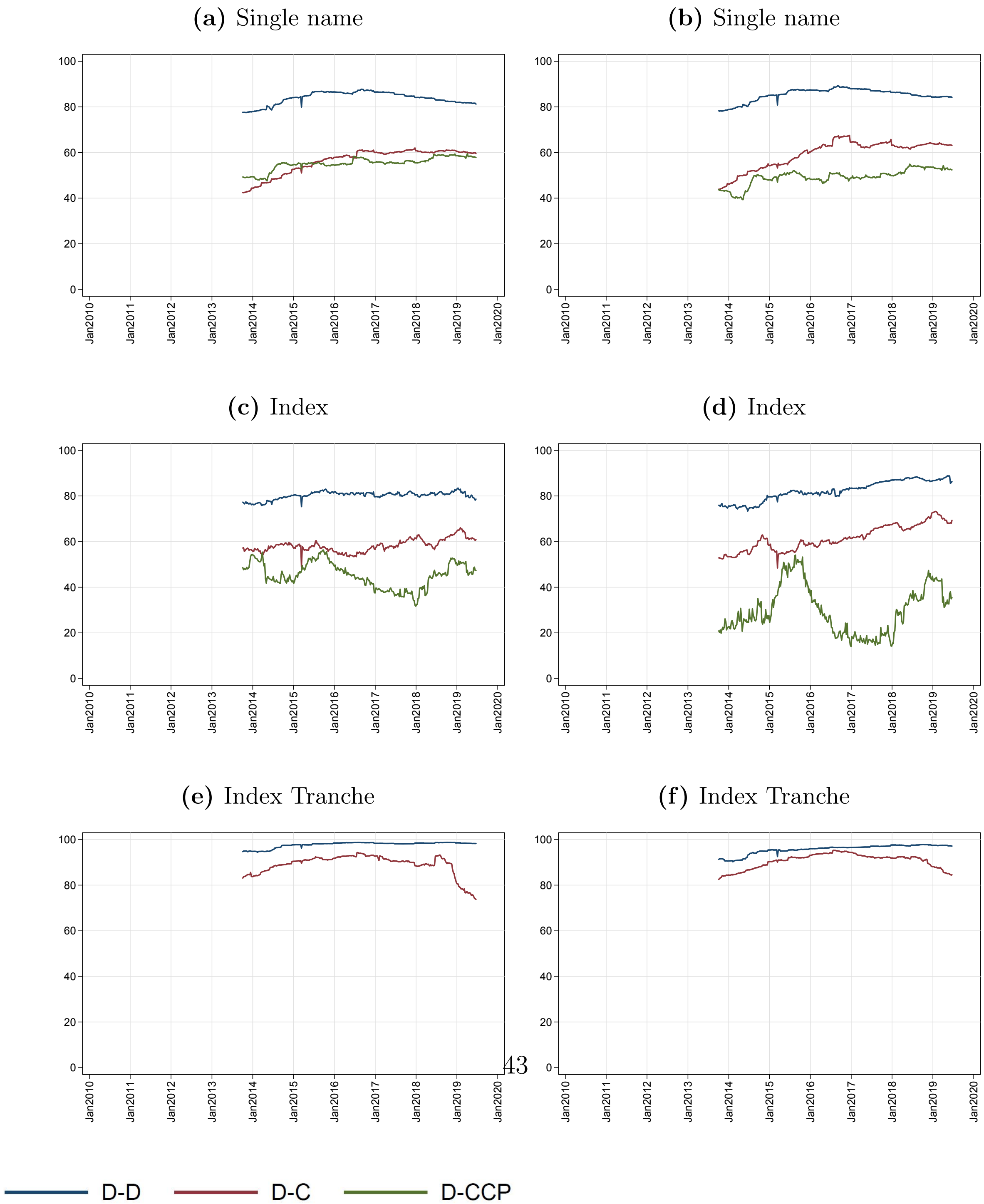
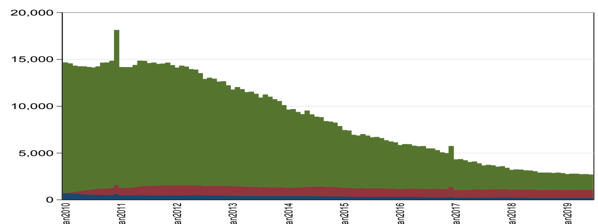
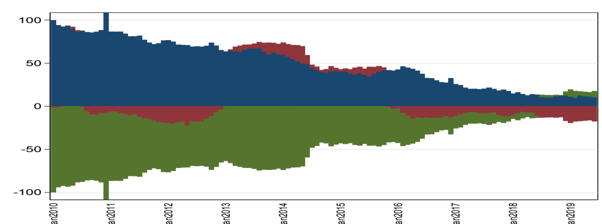


Figure 5. Monthly average gross and net positions by participant type. Left column: monthly average gross notional of outstanding positions in single-name, index, index tranche and index option contracts of different participant types; right column: monthly average net notional of positions in single-name, index, index tranche and index option contracts of different participant types. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection. Participant classification provided by DTCC.

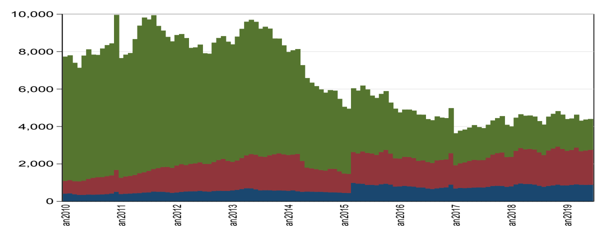
(a) Single name



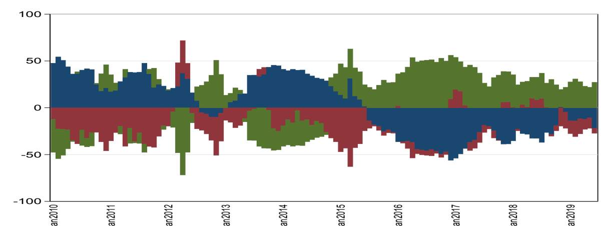
(b) Single name



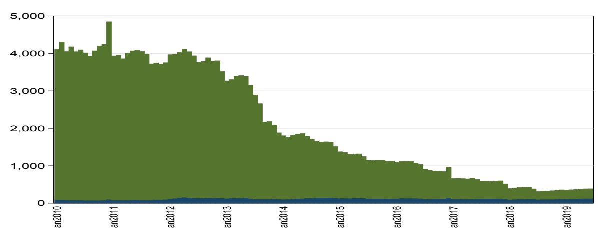
(c) Index



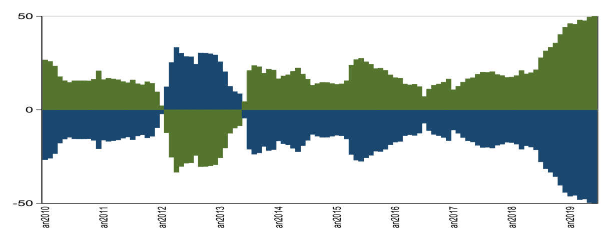
(d) Index



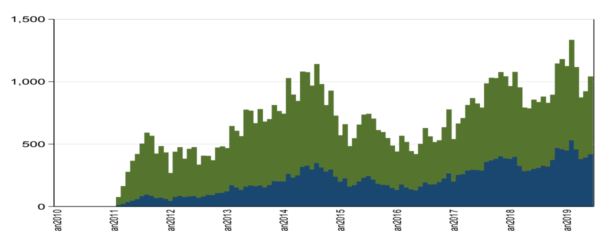
(e) Index tranches



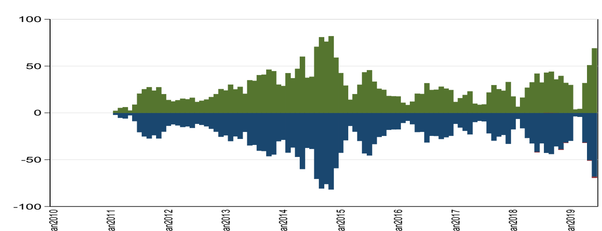
(f) Index tranches



(g) Index options



(h) Index options



Dealer Buyside CCP

Figure 6. Monthly average gross and net positions by location of counterparty. Left column: monthly average gross notional of outstanding positions in single-name, index, index tranche and index option contracts by location of the counterparty to the contract; right column: monthly average net notional of new positions in single-name, index, index tranche and index option contracts by location of the counterparty to the contract. “Home” refers to counterparties domiciled in the same jurisdiction. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection.

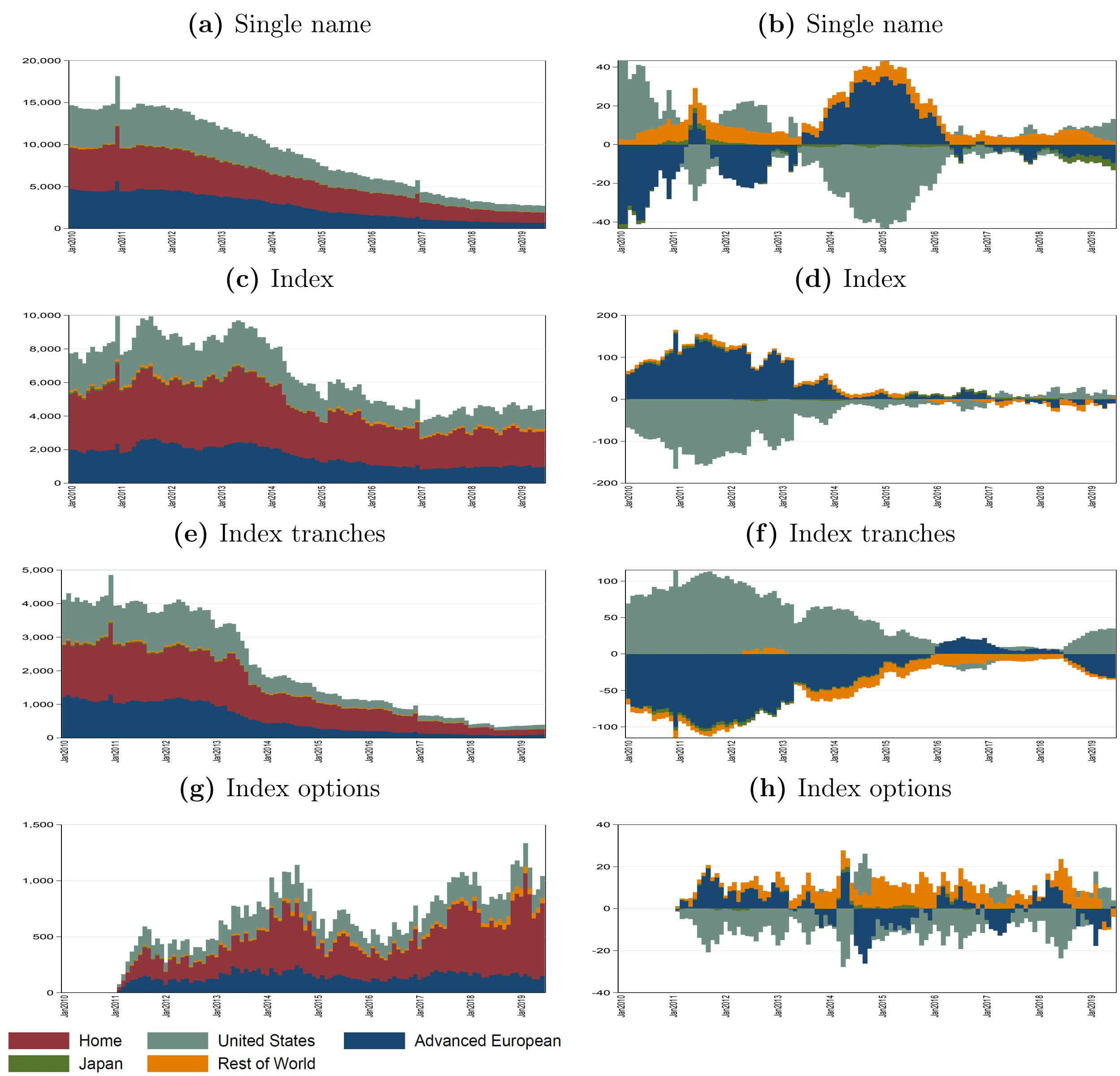
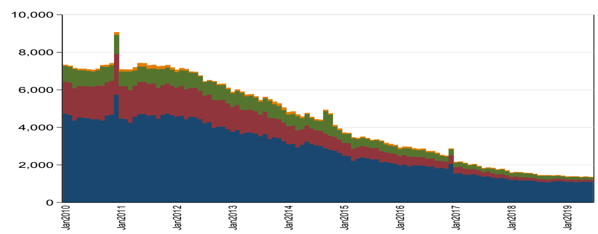
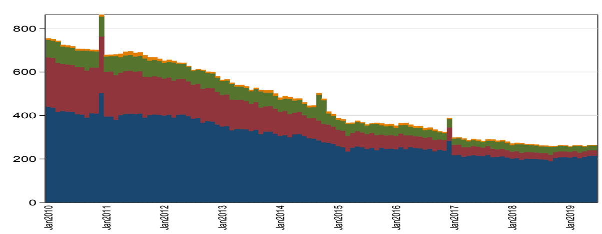


Figure 7. Monthly average gross and net positions by type of index. Left column: monthly average gross notional of outstanding positions in single-name, index, index tranche and index option contracts by type of index; right column: monthly average net notional of new positions in single-name, index, index tranche and index option contracts by clearing eligibility. For index tranches and index options, "on-the-run" corresponds to tranches and options written on on-the-run indices. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection.

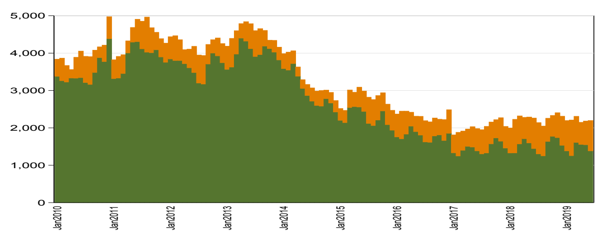
(a) Single name



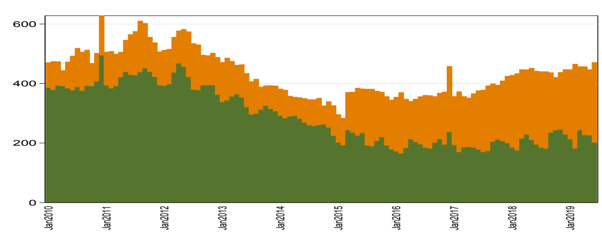
(b) Single name



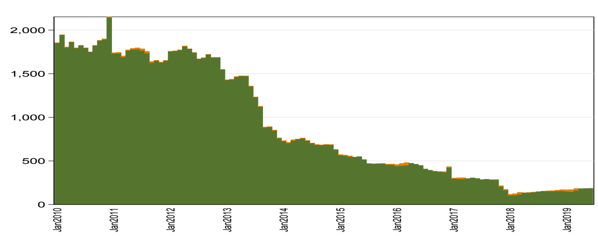
(c) Index



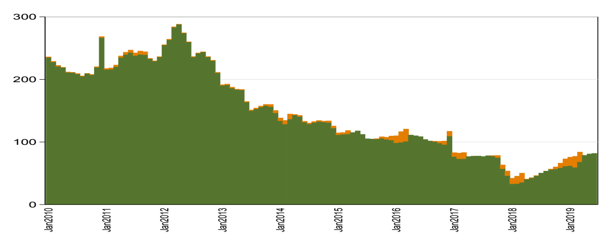
(d) Index



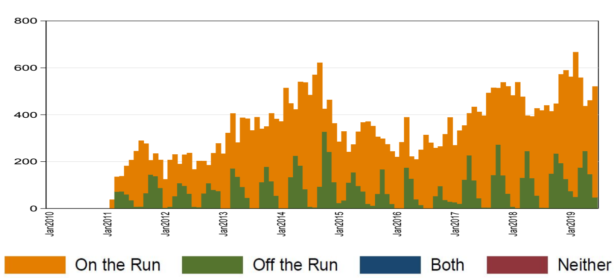
(e) Index tranches



(f) Index tranches



(g) Index options



(h) Index options

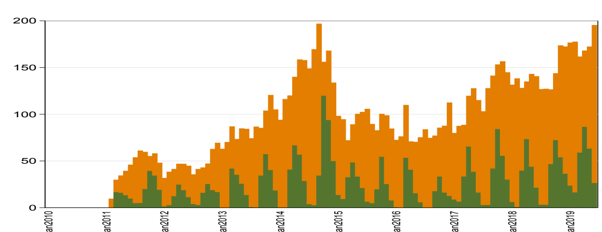
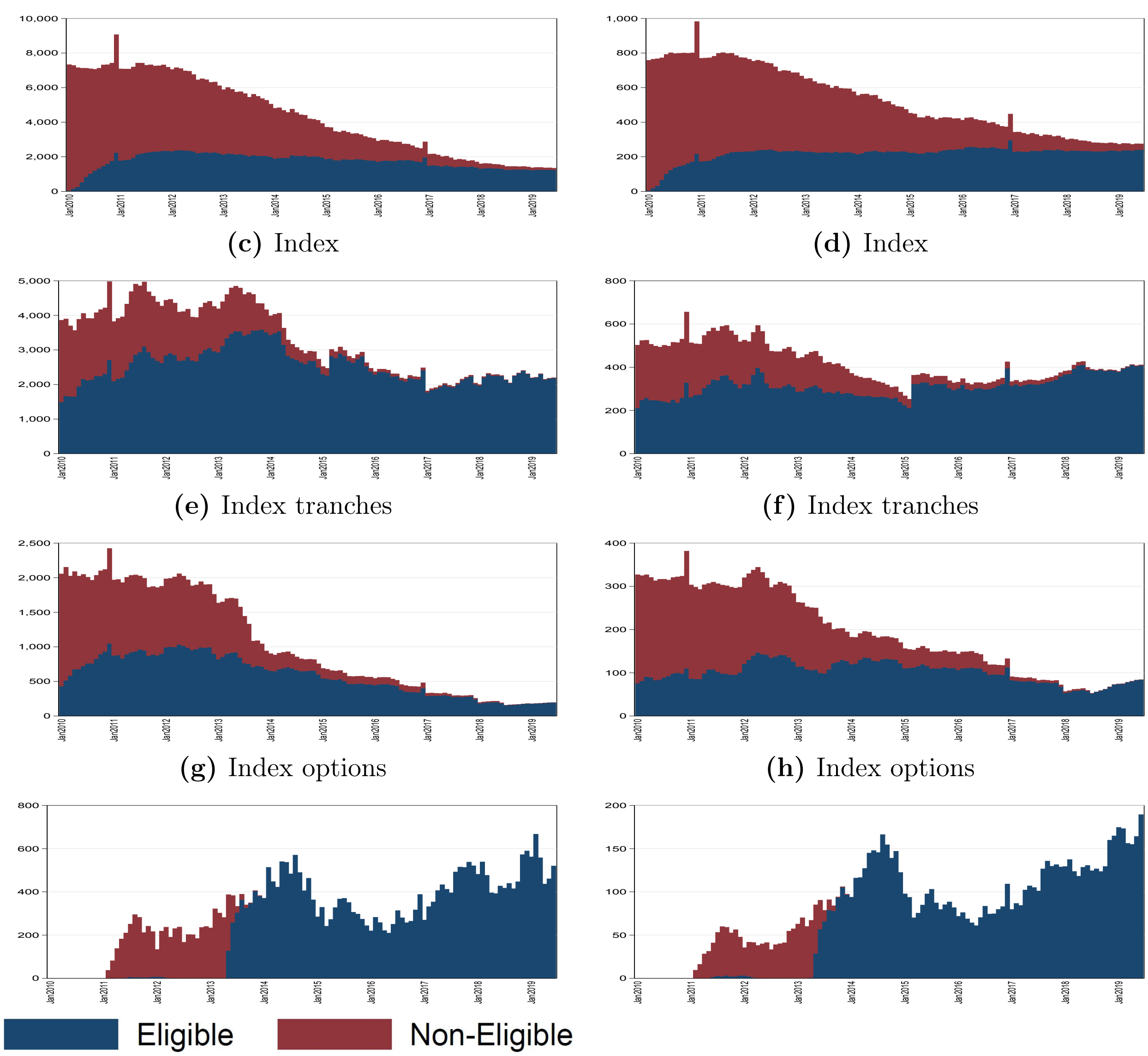


Figure 8. Monthly average gross and net positions by clearing eligibility. Left column: monthly average gross notional of outstanding positions in single-name, index, index tranche and index option contracts by clearing eligibility, determined as described in the online appendix; right column: monthly average net notional of new positions in single-name, index, index tranche and index option contracts by clearing eligibility. For index tranches and index options, "clearing-eligible" corresponds to tranches and options written on clearing-eligible indices. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection.



(a) Single name
(b) Single name
(c) Index
(d) Index
(e) Index tranches
(f) Index tranches
(g) Index options
(h) Index options

Figure 9. Monthly average gross and net positions by ISDA master agreement. Left column: monthly average gross notional of outstanding positions in single-name, index, index tranche and index option contracts by ISDA master agreement; right column: monthly average net notional of new positions in single-name, index, index tranche and index option contracts by clearing eligibility. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection.

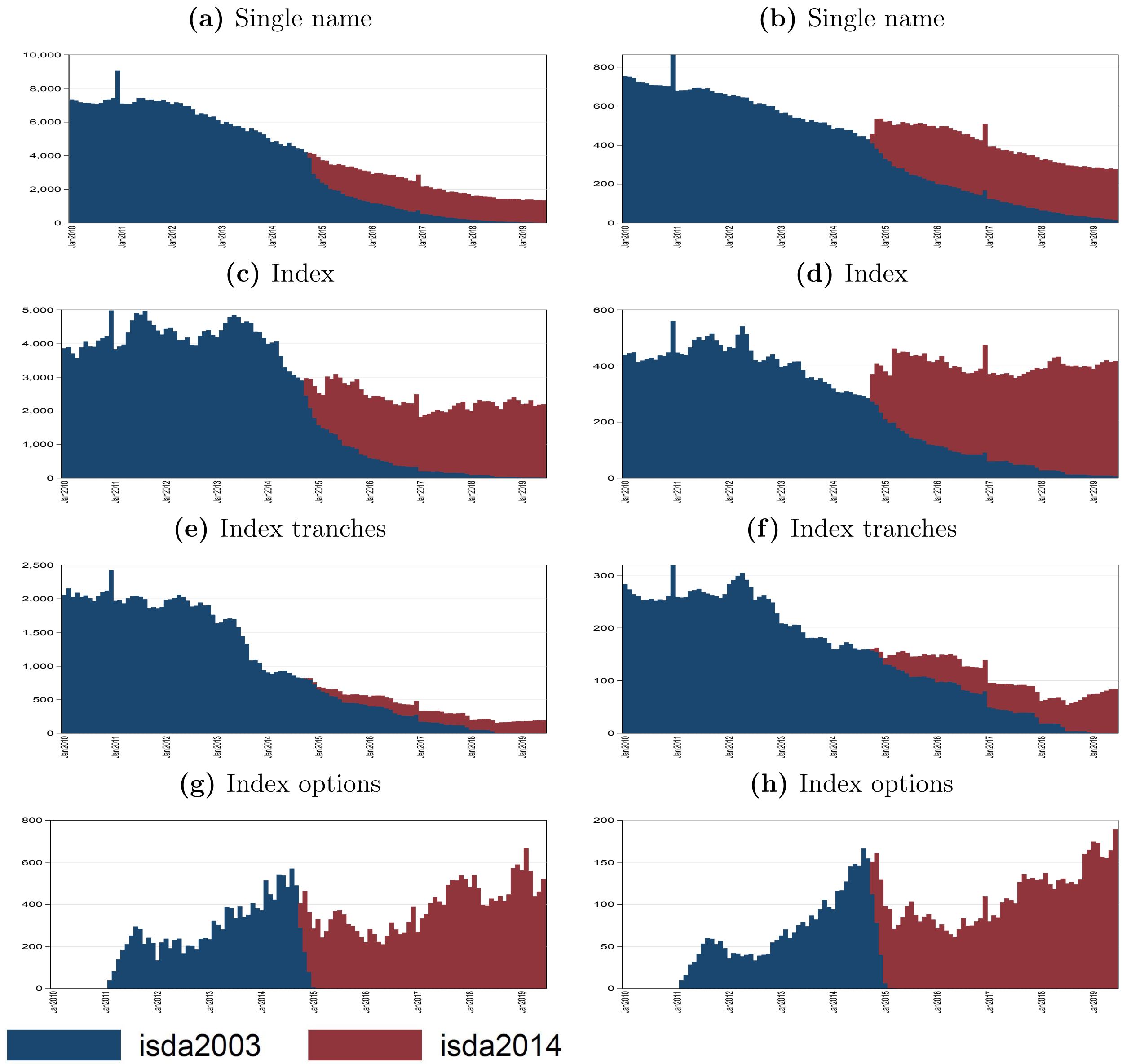


Figure 10. Monthly average gross and net positions by credit rating. Left column: percent of monthly average gross notional of new positions in single-name, index, index tranche and index option contracts for different credit rating categories; right column: monthly average net notional of new positions in single-name, index, index tranche and index option contracts for different credit rating categories. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection. Credit rating information is sourced from Markit.

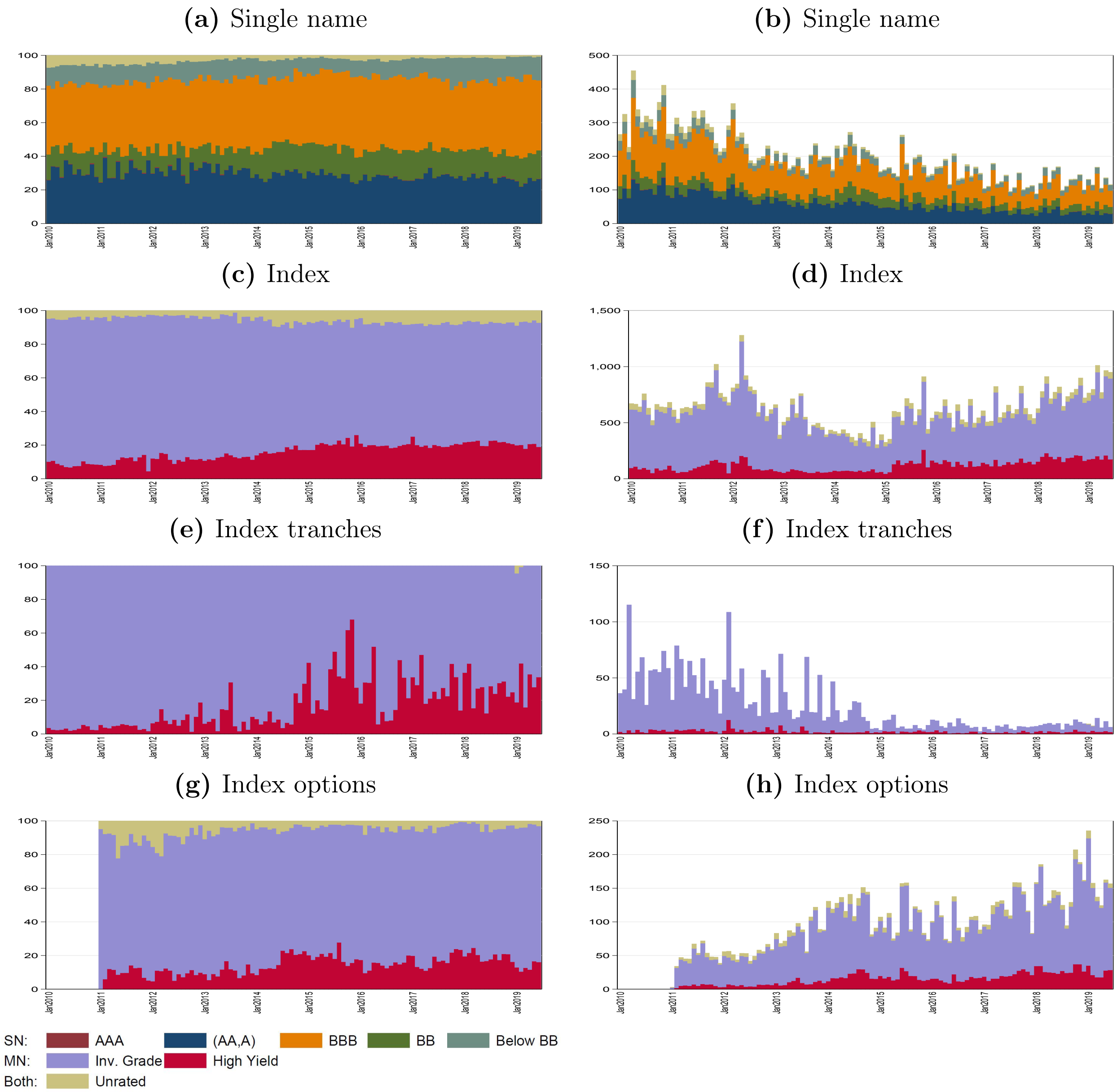


Figure 11. Monthly average gross and net positions by initial maturity. Left column: percent of monthly average gross notional of new positions in single-name, index, index tranche and index option contracts across initial maturity buckets; right column: monthly average net notional of new positions in single-name, index, index tranche and index option contracts across initial maturity buckets. For index options, maturity is the maturity of the option, not the underlying index. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection.

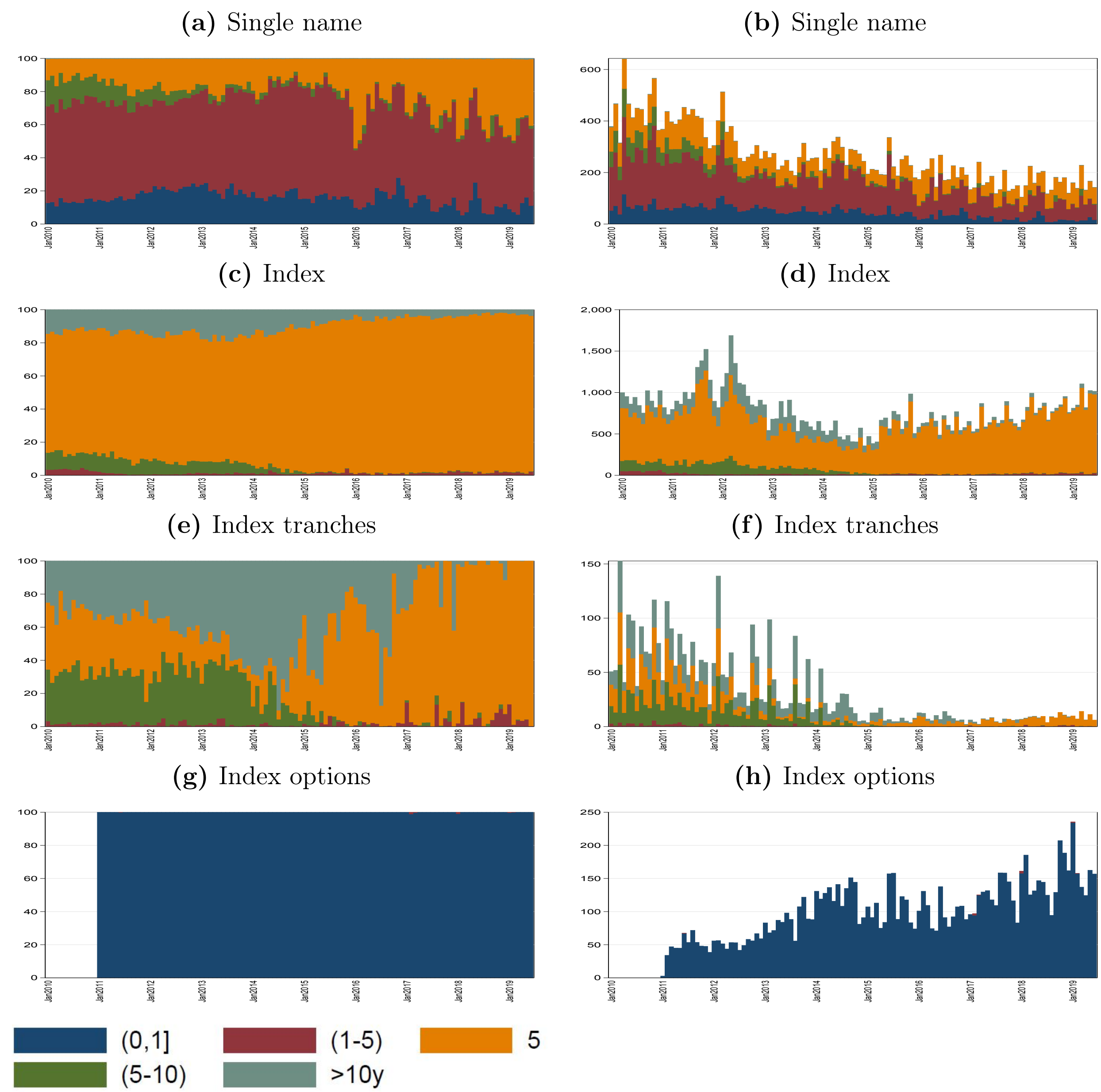
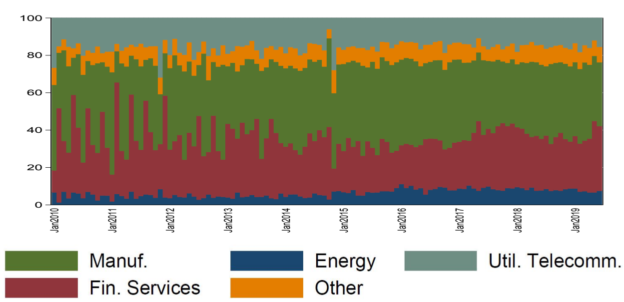


Figure 12. Monthly average gross and net positions by sector. Left column: percent of monthly average gross notional of new positions in single-name contracts by reference entity sector; right column: monthly average net notional of new positions in single-name contracts by reference entity sector. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection. Reference entity sector information from Markit.

(a) Gross notional



(b) Net notional

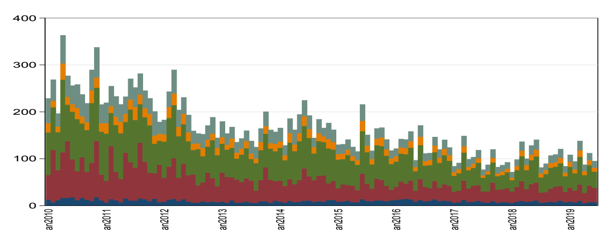
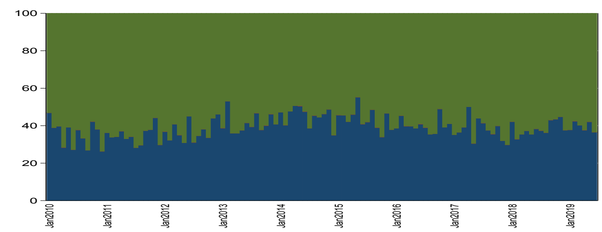
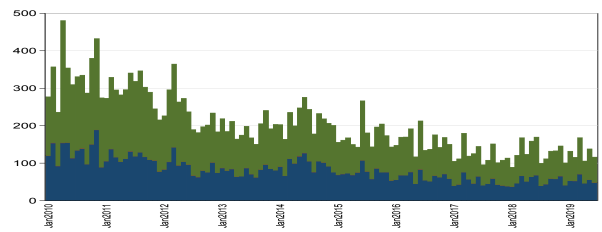


Figure 13. Monthly average gross and net positions by contract currency. Left column: percent of monthly average gross notional of new positions in single-name, index, index tranche and index option contracts by contract currency; right column: monthly average net notional of new positions in single-name, index, index tranche and index option contracts by contract currency. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection.

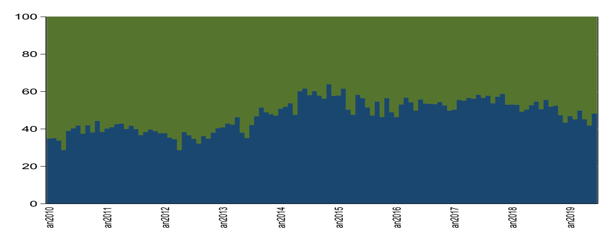
(a) Single name



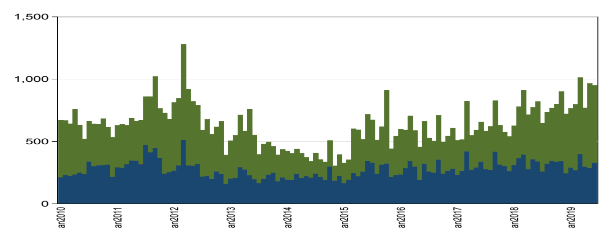
(b) Single name



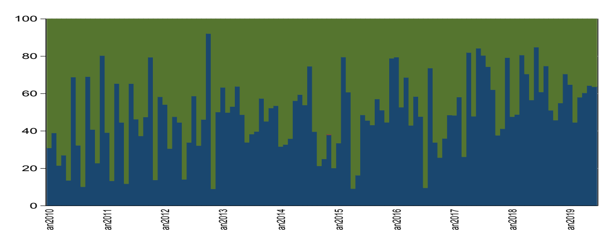
(c) Index



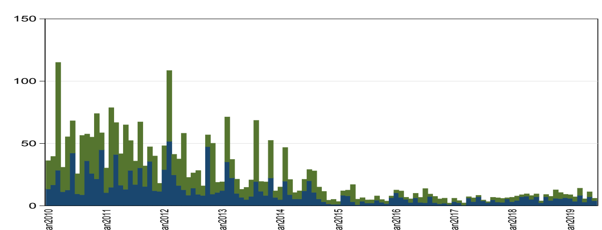
(d) Index



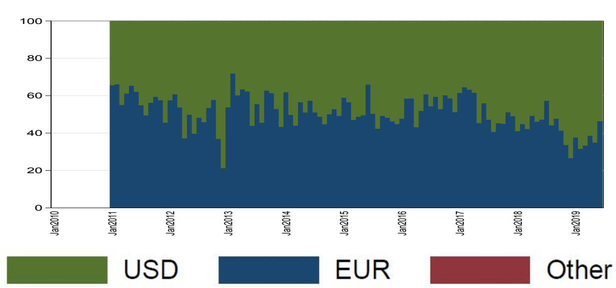
(e) Index tranches



(f) Index tranches



(g) Index options



(h) Index options

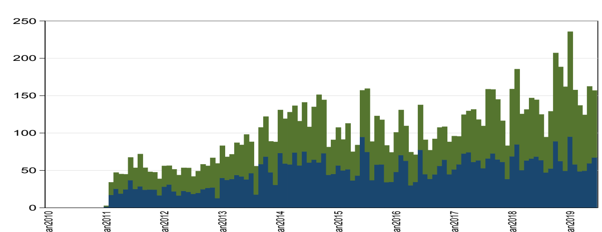


Table 1: Sample summary statistics. This table reports the summary statistics for the sample of positions (Table 1a) and transactions (Table 1b) used in the paper. The first row of each sub-table reports the characteristics of the full sample available; each subsequent row describes how the dataset changes with each filter applied. "RedCodes" column is the number of unique Markit RedIDs in the sample; "buyers" ("sellers") columns are the number of unique firm organizations id numbers in the sample that bought (sold) protection.

(a) Positions

Sample	RedCodes	Contracts	Buyers	Sellers
Original	4,049	14,641,667	13,997	12,934
...and 2010-2019 (June)	3,427	12,971,160	13,474	12,555
...and SN, Index Product Corporate	2,801	12,945,839	13,465	12,543
...and US/EUR Corporate	1,773	10,353,448	11,129	10,584
...and 5Y Maturity	1,351	3,673,703	10,264	9,521

(b) Transactions

Sample	RedCodes	Contracts	Buyers	Sellers
Original	3,547	16,928,937	15,074	14,097
...and Confirmed, Traded, Mkt	2,632	7,133,415	13,820	13,074
...and 2010 to 2019 (June)	2,632	7,133,415	13,820	13,074
...and SN, Index Corporate	2,316	6,209,021	12,457	11,999
...and US/EUR Corporate	1,661	5,681,160	11,529	11,098
...and 5Y Maturity	1,313	3,865,696	10,742	10,104
...and Default Doc. Clause	1,313	3,865,567	10,742	10,103
...and Restructuring Indicator	1,283	3,861,120	10,737	10,101
...and Local Currency	1,151	3,747,863	10,654	10,035
...and Converted, Non-Missing	1,139	3,741,915	10,648	10,024
...and matched to Markit	1,016	3,476,964	10,365	9,829

Table 2: Distribution of fixed spreads. This table reports the distribution of fixed spreads in the transactions data, conditioning on confirmed trades, market risk indicator equals "Y," and 5-year maturity. We report the distribution separately for U.S. corporate single-name, European corporate single-name, and for U.S. and European corporate indices. Percentage of gross notional calculated within a jurisdiction. For contracts on U.S. reference entities, only contracts denominated in USD are used; for contracts on European reference entities, contracts denominated in EUR (for non-U.K. reference entities) and GBP (for U.K. reference entities) are used.

(a) Number of transactions

	0	25	100	300	500	Other	Composite Depth
United States							
US SN IG	14	0	324,400	0	21,766	6	7
US SN HY	4	0	35,278	0	187,153	7	7
CDX.NA.IG	0	0	335,241	0	17	10,911	13
CDX.NA.HY	0	0	0	1	350,994	2,343	12
Europe							
EUR SN IG	4	10	184,336	12,805	14,248	27	8
EUR SN HY	4	0	27,431	511	81,989	28	8
iTraxx Europe	0	0	423,999	0	2	6,277	14
iTraxx Europe Xover	1	0	0	0	360,179	425	14

(b) Percent of gross notional

	0	25	100	300	500	Other	Composite Depth
United States							
US SN IG	0.0	0.0	5.0	0.0	0.3	0.0	7
US SN HY	0.0	0.0	0.4	0.0	1.6	0.0	7
CDX.NA.IG	0.0	0.0	68.7	0.0	0.0	4.9	13
CDX.NA.HY	0.0	0.0	0.0	0.0	18.5	0.6	12
Europe							
EUR SN IG	0.0	0.0	3.2	0.2	0.2	0.0	8
EUR SN HY	0.0	0.0	0.4	0.0	0.8	0.0	8
iTraxx Europe	0.0	0.0	73.4	0.0	0.0	2.9	14
iTraxx Europe Xover	0.0	0.0	0.0	0.0	18.8	0.0	14

Table 3: Transaction costs summary statistics. This table reports the mean and standard deviation of transactions costs by market (U.S. and European corporate reference entities), product type (single-name and index), and fixed rate. Transaction cost measured as the absolute difference between the par-equivalent spread from transactions and quoted spread in Markit for standard five-year contracts.

	FR = 100		FR = 500	
	Mean	St. Dev	Mean	St. Dev
United States				
US SN IG	3.85	6.13	13.56	24.28
US SN HY	10.93	11.27	31.20	56.94
CDX.NA.IG	5.47	9.76	10.56	10.33
CDX.NA.HY	.	.	22.50	45.35
Europe				
EUR SN IG	10.48	25.84	91.84	116.64
EUR SN HY	11.75	14.74	25.97	47.72
iTraxx Europe	3.95	5.81	.	.
iTraxx Europe Xover	.	.	19.48	45.10

Table 4: Transaction costs in the single-name market. This table reports the estimated coefficient from the regression of the transaction cost of standard five-year single-name contracts on U.S. and European corporate reference entities on the log notional of the trade, clearing eligibility indicator, investment grade indicator, industry, and buyer-seller type. "In an index" indicates whether the single-name is included in the on-the-run version of the index only, off-the-run version of the index only, both on-the-run and off-the-run versions of the index, and neither, at the time of the transaction. Clearing eligibility is equal to one when the single-name becomes accepted for clearing on a CCP. Industry and investment grade classification based on Markit. Transaction cost measured as the absolute difference between the par-equivalent spread from transactions and quoted spread in Markit. Dependent variable is winsorized at the 1% level to remove outliers. t-statistics based on standard errors clustered at the Quarter-Buyer-Seller level reported in parentheses below the point estimates; all regressions include week fixed effects; columns 3, 4, 7, and 8 also include reference entity and reference entity × week fixed effects. The omitted (base) categories for industry, buyer-seller type, and index inclusion are manufacturing, dealer-dealer, and not in an index, respectively. *** significant at 1%, ** significant at 5%, * significant at 10%.

	US				Europe			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log notional	-0.37	-1.78	-0.04	-0.24	-1.38	-1.81	-1.09	-0.81
	(0.02)***	(0.29)***	(0.01)***	(0.09)***	(0.09)***	(0.32)***	(0.08)***	(0.22)***
Investment grade	-7.06	-16.31	-1.02	-7.70	-9.09	58.89	0.05	67.32
	(0.11)***	(0.99)***	(1.01)	(5.35)	(0.23)***	(1.78)***	(1.07)	(55.19)
Clearing-eligible	0.20	-4.61	-2.41	1.56	8.82	21.44	-0.88	2.60
	(0.08)**	(1.61)***	(0.66)***	(5.08)	(0.43)***	(1.46)***	(4.46)	(1.57)*
Industry:								
Fin. Services	-0.24	5.15			28.92	60.43		
	(0.06)***	(1.00)***			(0.41)***	(1.40)***		
Energy	2.56	6.63			1.27	-6.55		
	(0.15)***	(1.44)***			(0.36)***	(3.33)**		
Util. Telecomm.	0.34	12.93			-1.64	-11.63		
	(0.09)***	(1.23)***			(0.14)***	(0.90)***		
Other	0.43	20.36			-1.07	5.58		
	(0.06)***	(0.77)***			(0.17)***	(0.76)***		
In an index:								
On the Run	0.46	6.91	-3.88	5.50	3.31	-20.70	24.50	5.46
	(0.20)**	(1.87)***	(5.21)	(7.53)	(0.77)***	(3.48)***	(10.71)**	(9.09)
Both	-0.81	2.78	-10.52	13.28	6.37	-30.19	32.73	17.30
	(0.07)***	(0.97)***	(6.98)	(7.91)*	(0.45)***	(3.14)***	(10.74)***	(11.59)
Off the Run	-0.71	27.40	-9.79	18.01	3.78	-22.84	38.63	39.96
	(0.08)***	(1.77)***	(7.00)	(7.92)**	(0.46)***	(3.94)***	(13.93)***	(19.50)**
Buyer × Seller Type:								
Buyside × Dealer	1.81	-4.07	1.33	4.60	1.90	11.31	1.89	9.04
	(0.08)***	(0.85)***	(0.07)***	(0.35)***	(0.51)***	(1.62)***	(0.55)***	(1.03)***
× Clearing-eligible	0.61	11.84	0.40	-0.36	-8.31	-12.25	-5.06	-0.07
	(0.13)***	(1.90)***	(0.11)***	(0.95)	(0.63)***	(1.95)***	(0.72)***	(1.51)
Dealer × Buyside	-0.78	-5.42	-1.12	-4.08	-0.51	-5.49	0.33	-5.61
	(0.09)***	(1.14)***	(0.07)***	(0.34)***	(0.66)	(1.21)***	(0.77)	(0.77)***
× Clearing-eligible	2.21	3.39	-0.29	0.64	-8.67	0.28	-9.37	-0.63
	(0.18)***	(1.99)*	(0.16)*	(0.82)	(0.76)***	(1.83)	(0.95)***	(1.42)
Sample	100bp	500bp	100bp	500bp	100bp	500bp	100bp	500bp
Week FE	✓	✓	✓	✓	✓	✓	✓	✓
Ref. Entity FE			✓	✓			✓	✓
Ref. Entity FE × Week			✓	✓			✓	✓
Adj. R-sqr.	0.18	0.07	0.68	0.86	0.26	0.30	0.55	0.75
N. of obs.	261354	178951	241526	171833	159620	83205	149428	79072

Table 5: Transaction costs in the index market. This table reports the estimated coefficient from the regression of the transaction cost of standard five-year index contracts on U.S. and European reference entities on the log notional of the trade, clearing eligibility indicator, and buyer-seller type. Clearing indicator is equal to one when the index becomes accepted for clearing on a CCP. Transaction cost measured as the absolute difference between the par-equivalent spread from transactions and quoted spread in Markit. Dependent variable is winsorized at the 1% level to remove outliers. t-statistics based on standard errors clustered at the Quarter-Buyer-Seller level reported in parentheses below the point estimates; all regressions include week, index family, and index family × week fixed effects. The omitted (base) categories for buyer-seller type and on-the-run status are dealer-dealer, and off-the-run, respectively. *** significant at 1%, ** significant at 5%, * significant at 10%.

	US		Europe	
	(1)	(2)	(3)	(4)
Log notional	-0.03	0.12	-0.00	-0.10
	(0.01)***	(0.06)**	(0.01)	(0.03)***
Clearing-eligible	0.22	-3.45	-1.00	-12.49
	(0.21)	(0.50)***	(0.20)***	(1.19)***
On-the-run status:				
On the Run	-0.78	4.13	1.65	4.96
	(0.08)***	(0.50)***	(0.10)***	(0.33)***
Buyer × Seller Type:				
Buyside × Dealer	0.66	3.55	1.11	2.21
	(0.17)***	(0.37)***	(0.16)***	(0.83)***
× Clearing-eligible	-0.37	-0.91	-0.97	-1.40
	(0.17)**	(0.40)**	(0.16)***	(0.83)*
Dealer × Buyside	1.59	2.09	0.44	2.69
	(0.17)***	(0.43)***	(0.17)**	(1.12)**
× Clearing-eligible	-1.64	-2.55	-0.51	-2.61
	(0.18)***	(0.45)***	(0.17)***	(1.12)**
Sample	100bp	500bp	100bp	500bp
Week FE	✓	✓	✓	✓
Ref. Entity FE	✓	✓	✓	✓
Ref. Entity FE × Week	✓	✓	✓	✓
Adj. R-sqr.	0.65	0.65	0.68	0.66
N. of obs.	103905	87029	135548	117746

Online Appendix for The Long and Short of It: The Post-Crisis Corporate CDS Market

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Abstract

This online appendix describes the details of the data cleaning and construction, and provides additional evidence supporting the analysis in the main text.

A The DTCC Data

Participants submit their trade records to the DTCC's Trade Reporting Repository for operational purposes. It allows them to maintain and track the most current contract details on the official, or "gold," record for both cleared and bilateral CDS transactions. The DTCC estimates that it captures approximately 98% of all credit derivative transactions in the global marketplace. The DTCC's customer base includes all major global derivatives dealers and more than 2500 buyside firms and other market participants located in over 70 countries.

Trade records are submitted by participants to the system. The quality of reporting varies across participants and across time. We detail below the filters and data adjustments applied for the positions data (Section A.1) and for the transaction dataset (Section A.2) to avoid biases in our empirical analyses.

A.1 Positions Data

We append weekly snapshots of position data into a single dataset.

Next, we apply the following filters:

1. A single position is recorded from the point of view of each party. We remove duplicate records based on the transaction id (`dtcc_reference_id`), which is assigned by the DTCC upon submission, and reporting date (`rpt_date_key`).

   There are some records for which `rpt_date_key` is missing. When it is missing, we use the date in the file name, which corresponds to the date for which the data was captured.

2. We backfill RED code (`red_id`). RED codes are alphanumeric codes assigned to reference entities and reference obligations, and are used to confirm trades on trade matching and clearing platforms.

3. We use the RED code to backfill key variables related to the reference entity: reference entity location (`reference_entity_jurisdiction`), and reference entity sector (`reference_entity_sector`).

4. We use RED codes to backfill locations of the counterparties (`counterparty_settlement_location`).

5. We keep records where `transaction_status = Certain`.

6. We keep records where `reference_entity_type` ∈ {CORP, INDEX, missing}, and exclude records where `reference_entity_type` ∈ {CMBS, ECMBS, ELCDS, ERMBS, MUNI, Other, RMBS, SOV, STATBODY, STATE, SUPRA}.

7. We create a variable called `prod_type` based on the values of two variables, `product_type` and `subproduct_type`, as follows:

`prod_type`	`product_type`	`subproduct_type`
Single Name	CreditDefaultSwapShort	(missing)
Index	CreditDefaultSwapIndex	(missing)
Index Option	CreditDefaultSwapIndex	('OPTION', 'SWAPTION')
Index Tranche	CreditDefaultSwapIndexTranche	(missing)

8. The notional values in the positions dataset as delivered by the DTCC are scaled down by a factor of 100 from January 2011 through April 2016. We multiply these values by 100.[a1]

After the initial cleaning of the data, we apply the following conditions to construct the samples of outstanding and new positions that are used for Figures 5 – 13 in the main text:

1. Exclude reference entities located outside of U.S. and Advanced European economies.[a2]

2. Exclude the following indices: MBX, MCDX, LCDX, IOS, PO, ABX, IBOXX COCO, and IBOXX LOANS.

3. **Party Location** The location of a party is determined based on the reported settlement location rather than registered office. This is because the registered office data are far more sparse, but both contain almost the same information when both exist. The settlement location field (as well as the registered office) is at the account level. Therefore, there are cases where a party with multiple accounts is associated with multiple locations in the same week. For such cases, we keep the location of the party as the location of the account through which the most notional amount is traded in that week.

4. **Reference Entity Rating** The rating of a reference entity is assigned based on the rating at the reporting date, rather than the rating at origination.

   4.1 Ratings for single-name positions are obtained from Markit's composites by convention dataset. While the positions are at a weekly frequency, the rating data are at a daily frequency. We take the latest available rating from Markit in a

[a1] We confirmed with the DTCC that this factor should indeed be factored in. We do not know, however, whether this data issue affects other regulatory agencies using these historical data.

[a2] Advanced European countries include Austria, Belgium, Denmark, England and Wales, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Scotland, and the United Kingdom.

given week as the rating for the reference entity for that week. If the rating in Markit is missing for the week of the trade date, we use the latest available rating within the month prior to the trade date.

4.2 Ratings for Index, Index Option, and Index Tranche products are assigned based on the name of the product. CDX.NA.IG is considered investment grade, and CDX.NA.HY is considered high yield. Among regional iTraxx indices, the Europe Series, Senior Financial, and Asia Ex-Japan are considered investment grade. The European Crossover is considered high yield.

5. **Clearing** Clearing indicator is constructed from an amalgamation of three sources: ICE, CCP trades in the DTCC, and the mandatory clearing dates for indices. For each RED code, the reference entity is considered eligible for clearing starting the first trade date identified across the three sources. The first source is the list of clearable instruments published by ICE. For single-name contracts that are not required for clearing, ICE reports the date included for clearing for each reference entity (red6). ICE clears single-name contracts conditioned on a specific ISDA definition, tenor, and tier. ICE also reports clearing eligibility for indices and sovereigns. CDX and iTraxx Indices for which we do not find information through ICE are given a clearing date of April 26, 2013, the date of mandatory clearing for Category 1 indices. The iBoxx index family is never cleared. Lastly, we consider the earliest trade date at which one of the transacting parties is a CCP as a possible candidate for clearing date dummy for a specific reference entity.

6. The splits by location of counterparty, documentation id, participant type, clearing indicator, and reference entity location are performed on existing positions. The remaining splits are performed on new trades only. The new trade dataset is generated by taking the cleaned positions dataset and removing duplicate transaction identifiers based on trade date.

   All splits are filtered based on the split sample variable and exclude missing split variables. The exceptions are for the split by rating, where we include missing as its own category (*Unrated* category), and for the split by reference entity sector (*Other* category).

A.2 Transactions Data

As with the positions data, we append all the transaction datasets into a single dataset. In general, we follow cleaning steps similar to those for the positions dataset.

1. Transactions are reported by both parties. We remove duplicate reporting from the dataset based on the transaction id (`dtcc_reference_id`) and reporting date (`rpt_date_key`) of the contract. This includes removing "zero" DTCC reference ID transactions (`reference_id = 00000000.00000000`).

2. We backfill RED code (`red_id`). RED codes are alphanumeric codes assigned to reference entities and reference obligations, and are used to confirm trades on trade matching and clearing platforms. After the backfilling, we exclude observations with missing RED codes, as we need this identifier to later merge the traded spreads data with the quoted spreads data from Markit.

3. We use the RED code to backfill key variables related to the reference entity: reference entity location (`reference_entity_jurisdiction`), and reference entity sector (`reference_entity_sector`).

4. We use RED codes to backfill locations of the counterparties (`counterparty_settlement_location`).

5. We keep records where

   5.1 `transaction_type = Trade`

   5.2 `transaction_status = Confirmed`

   5.3 `market_risk_indicator = Y`

6. We keep records where `product_type` in (CDS,CDX) and missing `subproduct_type`.

7. We drop CMBX, LCDX, and MCDX contracts as identified by reference entity name.

8. Based on the values of `product_type`, `reference_entity_type`, and `restructuring_indicator`, we create a variable called `category`, defined as follows:

`category`	`product_type`	`reference_entity_type`	`restructuring_indicator`
U.S. Corporate	CDS	CORP	missing
U.S. Index	CDX	INDEX, missing	missing
EUR Corporate	CDS	CORP	`R`
EUR Index	CDX	INDEX, missing	missing

9. We omit contracts that do not fall into one of the categories above.

10. We exclude contracts for which the currency (`notional_currency`) differs from the one denominated in the locale. In the case of U.S. Corporate and CDX.NA indices, we keep USD-denominated contracts. In the case of single-name European contracts,

we keep EUR-denominated contracts in continental European countries, and GBP-denominated in England and Wales, the United Kingdom, and Scotland. For Western Europe iTraxx Indices, we keep EUR-denominated and GBP-denominated contracts.

After cleaning the transactions data, we merge transactions with composite spreads from Markit to construct the sample for the pricing regressions in Section 5 in the main text.

Markit quoted spreads are running spreads (i.e., the spread associated with zero upfront payment), while the majority of transactions are traded with a fixed coupon spread (usually 100 or 500 basis points), and an upfront payment. Therefore, we convert the upfront and fixed spread of each transaction reported in the DTCC to running spreads. The conversion allows us to compare the traded spreads and the quoted spreads.

We use the ISDA Standard Converter to convert the upfront + fixed spread to a running spread. Although the pricing model that underlies the converter makes some simplifying assumptions, such as a piecewise exponential survival curve, we choose to use the conversion because the model is intended to standardize the way in which the running spread can be converted to an upfront fee.

The converter requires some input parameters. Specifically:

- Swap and deposit rates are required to construct the discount curve. The rates are available through Markit.
- Recovery rate, which represents the estimated value of the contract post-default, is required as an input. CDS for investment-grade bonds generally assume a 40% recovery rate; CDS for lower-rated bonds often reflect lower estimated recovery rates. Hence, we use the recovery rate reported in Markit for a reference entity and seniority pair when available, or assume the standard 40% (when the probability of default is low, the recovery rate is at best an estimate).
- The price is assumed to be *dirty*, i.e., the price includes accrued interest.

For the regression sample the following filters are also applied:

1. Keep trades with 100 or 500 basis points fixed coupons.
2. Drop observations with missing Markit's running spread.
3. Drop observations where the converter fails to convert the upfront + fixed coupon to a running spread.
4. Exclude intra-family trades (same firm organization ids for the party and counterparty).

5. Drop observations where the restructuring type differs from the standardized one. Contracts that reference the same entity but have different restructuring type are priced differently. The restructuring type (i.e., docclause) defines what constitutes a credit event for the contract as well as any limitations on the deliverable debt in the event of a credit event.

6. In October 2014 new 2014 ISDA Credit Derivatives Definitions were introduced,[a3] replacing the 2003 ISDA Credit Derivatives Definitions. The new definitions constitute a major overhaul of the terms governing CDS contracts. Most new CDS trades entered into after the implementation date follow the 2014 ISDA definitions. Existing trades are allowed to be converted to the new definitions, but are not required to be. Contracts under different ISDA Definitions trade with different spreads. One of the reasons for the spread differntial is the introduction of government intervention as a new credit event with respect to non-U.S. financial reference entities under ISDA 2014 Definitions. Such a credit event is triggered when a government's action or announcement results in binding changes to certain obligations of a reference entity, such as a reduction or postponement of principal or interest.

   In Markit, the ISDA Definitions are differentiated by the suffix 14 in the `doccluase` variable. In the DTCC data, we use `documentation_id`, `confirmation_master_type`, and/or `master_type` variables to determine under which protocol the contract is traded. If `confirmation_master_type` or `master_type` includes 2014 or 2003, we use that as the year for ISDA Definitions. If those fields are missing, or do not include a year, we classify contracts as 2003 ISDA Definitions prior to October 3, 2014, and as 2014 ISDA Definitions thereafter.

   After this assignment of ISDA Definitions, we exclude observations where we cannot match across DTCC and Markit.

7. We drop client-client and client-CCP trades.

8. We winsorize the difference between traded spread and quoted spread at the 1% level, for each product type and market separately.

9. The dependent variable in our regressions is then taken to be the absolute value of the difference between the traded spread and the quoted spread.

[a3] The ISDA published the 2014 ISDA Credit Derivatives Definitions in February 2014, and trading using the new definitions was expected to begin for most standard CDS contracts on October 6, 2014 (although some transactions may use the 2014 Definitions starting on September 22).

B Risk-Adjusted Positions

In this appendix, we study the properties of the risky-duration-adjusted positions. More specifically, for each position of participant p in reference entity i at date t with time to maturity τ, we follow He et al. (2017) and compute the approximate risky duration of the position as

$$RD_{p,i,\tau,t} = \frac{1}{4} \sum_{j=1}^{4\tau_{p,i,t\tau,t}} e^{-\frac{j\left(\lambda_{it}+r_t^{j/4}\right)}{4}},$$

where $r_t^{j/4}$ is the risk-free yield on a Treasury maturing in $j/4$ years, and λ_{it} is the default hazard rate implied by the quoted (Markit) 5 year spread on reference entity i, date t

$$\lambda_{it} = 4 \log \left(1 + \frac{\text{Markit spread}_{it}}{4L_{it}}\right),$$

with L_{it} the priced loss-given-default for reference entity i on date t. The risk-adjusted gross and net notional for reference entity i on date t are then given by

$$\text{Risk-adjusted gross notional}_{it} = \sum_{p,\tau} RD_{p,i,\tau,t}\text{Notional bought}_{p,i,\tau,t}$$

$$\text{Risk-adjusted net notional}_{it} = \sum_{p} \left(\sum_{\tau} RD_{p,i,\tau,t}\text{Net position}_{p,i,\tau,t}\right) \mathbf{1}\left(\sum_{\tau} \text{Net position}_{p,i,\tau,t} > 0\right).$$

One caveat for this procedure is that it requires a match to a Markit quote on 5 year CDS contract on reference entity i on date t. We can compute the risky duration of the majority of the positions in single name and index contracts throughout our sample.

Figures A.1–A.5 plot monthly average duration-weighted gross and net notional of outstanding positions by counterparty type, counterparty location, on-the-run index membership, clearing eligibility, and master agreement type. Qualitatively, the results in Figures A.1–A.5 are similar to the unweighted gross and net notional of outstanding positions plotted in Figures 3 – 7 in the main text, with the only exceptions the net notional traded by participant type in the index market and the net notional traded by counterparty location in the single name and index markets. On a duration-adjusted basis, dealers become buyers of protection in the index market in the second half of 2012, about two years earlier than on an unadjusted basis. Figure A.2 further shows that, on a duration-adjusted basis, U.S. counterparties are buyers of protection from the rest of the world in both the single name and the index market starting in the second half of 2015, while, on an unadjusted basis, U.S.

counterparties have close to zero net positions throughout this period.

Figures A.6–A.9 plot the duration-weighted net notional of new positions by credit rating of the underlying reference entity, initial maturity of the contract, reference entity sector, and currency of the contract, together with the duration-weighted percent of new gross notional traded represented by each category. For new positions, the duration-adjusted positions are similar across the board to the unadjusted positions.

References

He, Z., B. Kelly, and A. Manela (2017): "Intermediary asset pricing: New evidence from many asset classes," *Journal of Financial Economics*, 126, 1–35.

Figure A.1. Duration-adjusted monthly average gross and net positions by participant type. Left column: duration-adjusted monthly average gross notional of outstanding positions in single-name and index contracts of different participant types; right column: duration-adjusted monthly average net notional of positions in single-name and index contracts of different participant types. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection. Participant classification provided by DTCC.

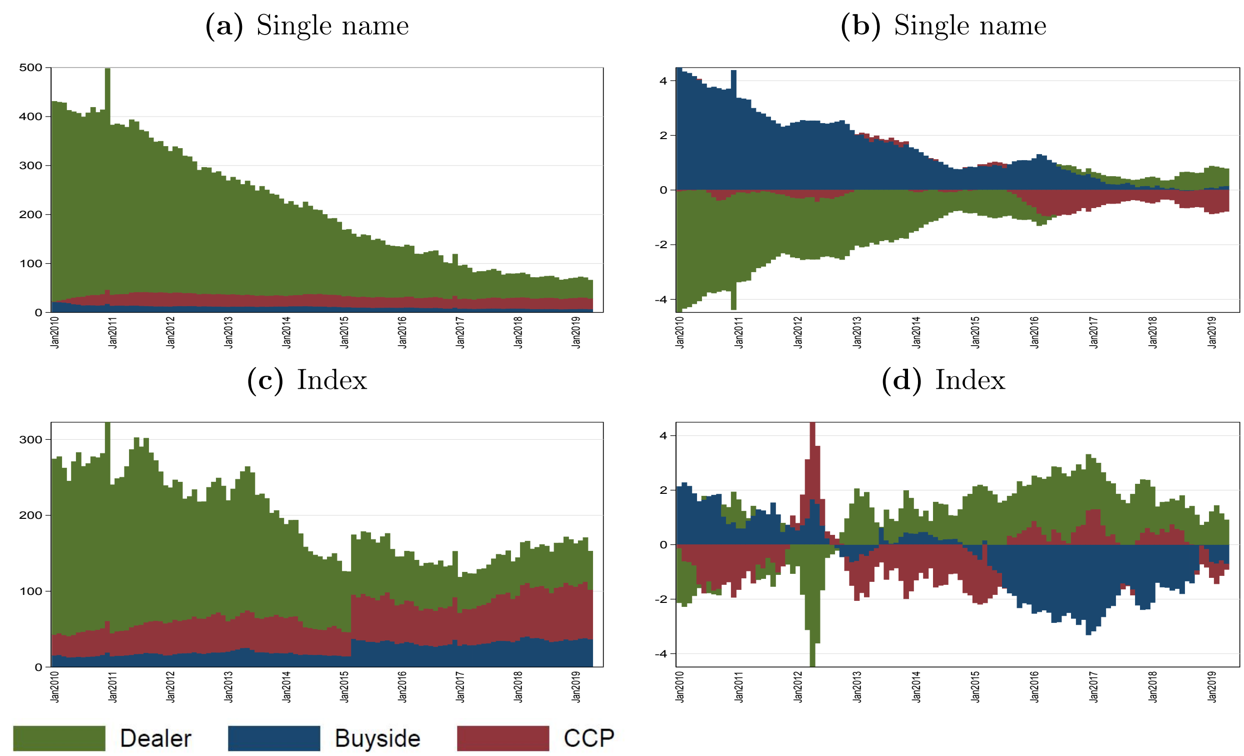


Figure A.2. Duration-adjusted monthly average gross and net positions by location of counterparty. Left column: duration-adjusted monthly average gross notional of outstanding positions in single-name and index contracts by location of the counterparty to the contract; right column: duration-adjusted monthly average net notional of new positions in single-name and index contracts by location of the counterparty to the contract. "Home" refers to counterparties domiciled in the same jurisdiction. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection.

(a) Single name **(b)** Single name

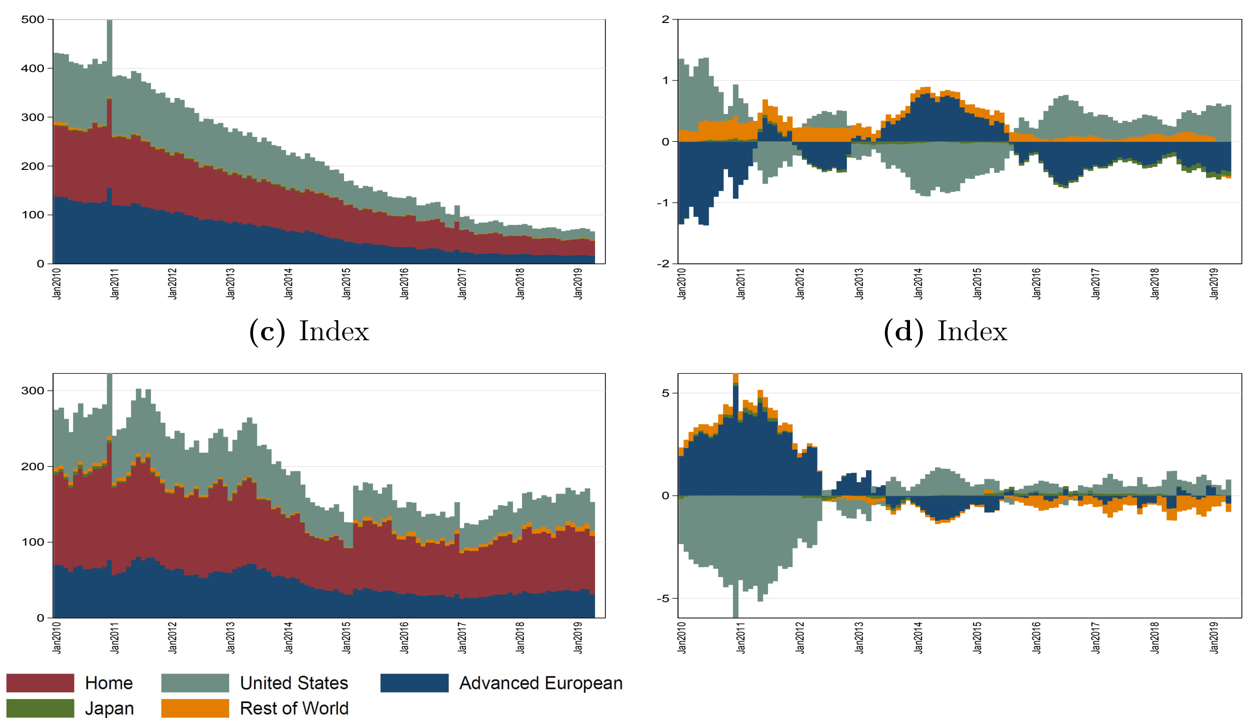


Figure A.3. Duration-adjusted monthly average gross and net positions by type of index. Left column: duration-adjusted monthly average gross notional of outstanding positions in single-name and index contracts by type of index; right column: duration-adjusted monthly average net notional of new positions in single-name and index contracts by clearing eligibility. For index tranches and index options, "on-the-run" corresponds to tranches and options written on on-the-run indices. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection.

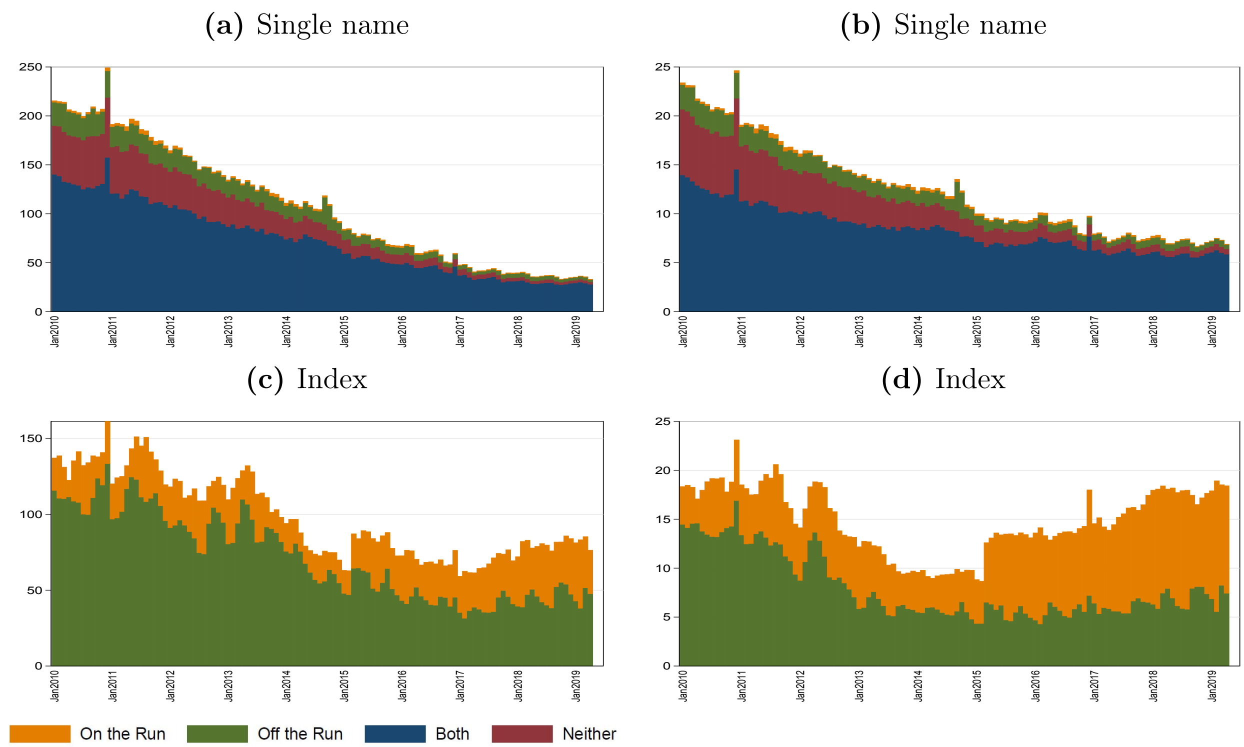


Figure A.4. Duration-adjusted monthly average gross and net positions by clearing eligibility. Left column: duration-adjusted monthly average gross notional of outstanding positions in single-name and index contracts by clearing eligibility, which is determined as explained in Appendix A.1; right column: duration-adjusted monthly average net notional of new positions in single-name and index contracts by clearing eligibility. For index tranches and index options, "clearing-eligible" corresponds to tranches and options written on clearing-eligible indices. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection.

(a) Single name

(b) Single name

(c) Index

(d) Index

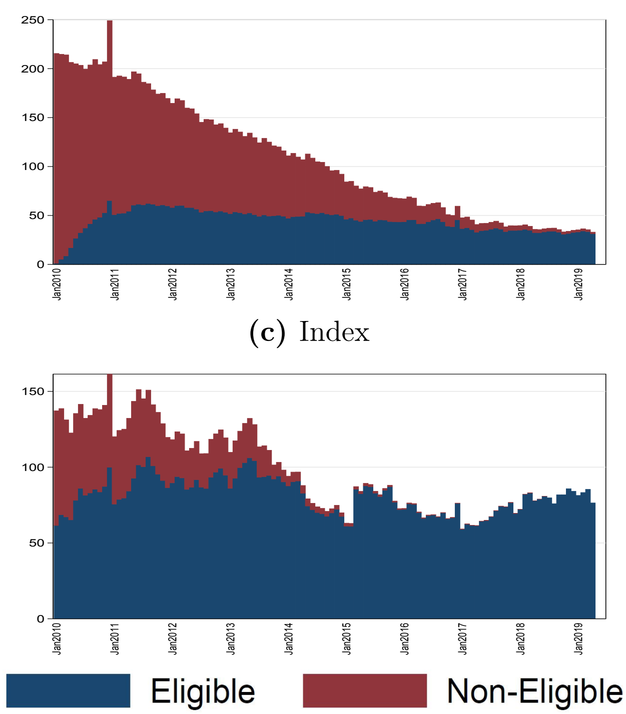
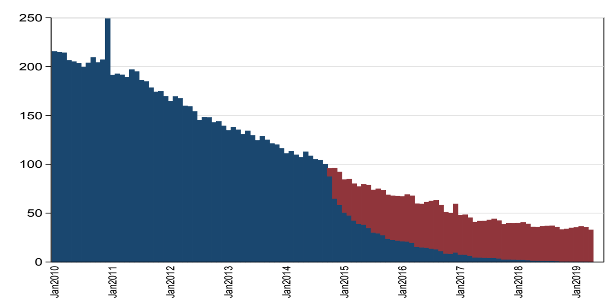
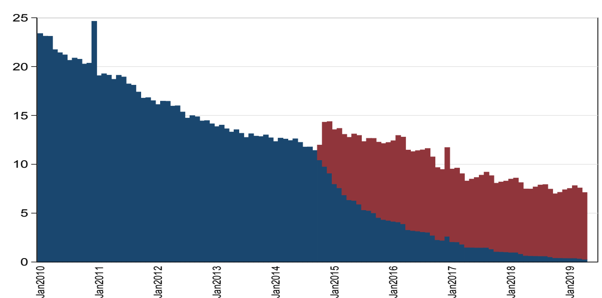


Figure A.5. Duration-adjusted monthly average gross and net positions by ISDA master agreement. Left column: duration-adjusted monthly average gross notional of outstanding positions in single-name and index contracts by ISDA master agreement; right column: duration-adjusted monthly average net notional of new positions in single-name and index contracts by clearing eligibility. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection.

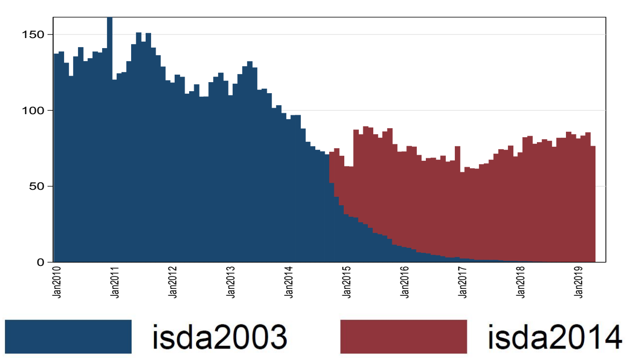
(a) Single name



(b) Single name



(c) Index



(d) Index

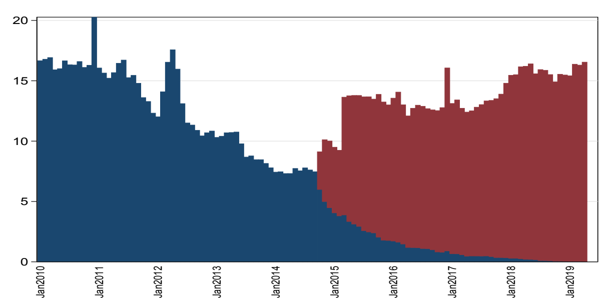


Figure A.6. Duration-adjusted monthly average gross and net positions by credit rating. Left column: percent of duration-adjusted monthly average gross notional of new positions in single-name and index contracts for different credit rating categories; right column: duration-adjusted monthly average net notional of new positions in single-name and index contracts for different credit rating categories. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection. Credit rating information is sourced from Markit.

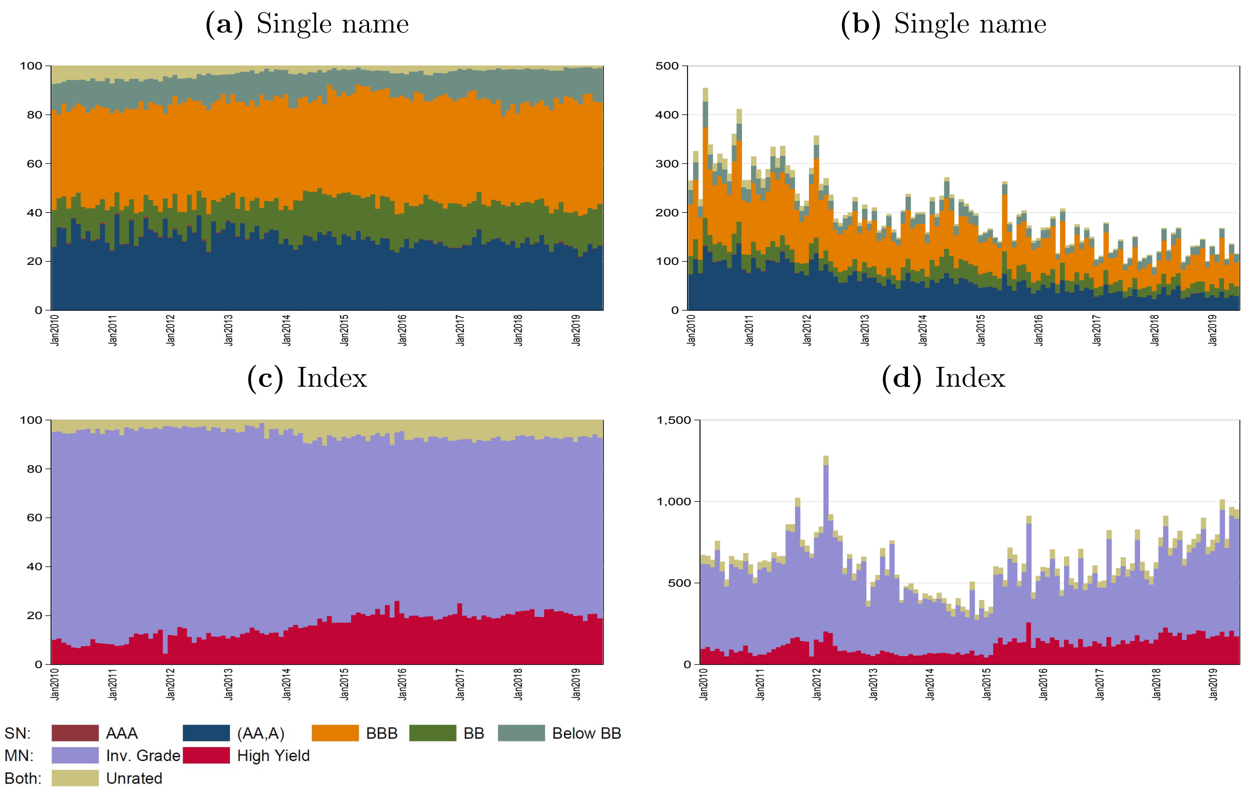


Figure A.7. Duration-adjusted monthly average gross and net positions by initial maturity. Left column: percent of duration-adjusted monthly average gross notional of new positions in single-name and index contracts across initial maturity buckets; right column: duration-adjusted monthly average net notional of new positions in single-name and index contracts across initial maturity buckets. For index options, maturity is the maturity of the option, not the underlying index. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection.

Figure A.8. Duration-adjusted monthly average gross and net positions by sector. Left column: percent of duration-adjusted monthly average gross notional of new positions in single-name contracts by reference entity sector; right column: duration-adjusted monthly average net notional of new positions in single-name contracts by reference entity sector. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection. Reference entity sector information from Markit.

(a) Gross notional | **(b)** Net notional

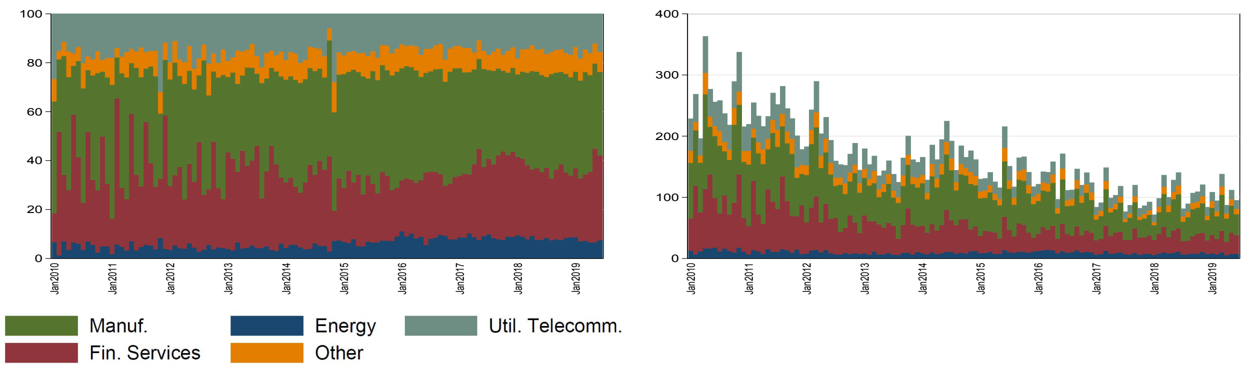
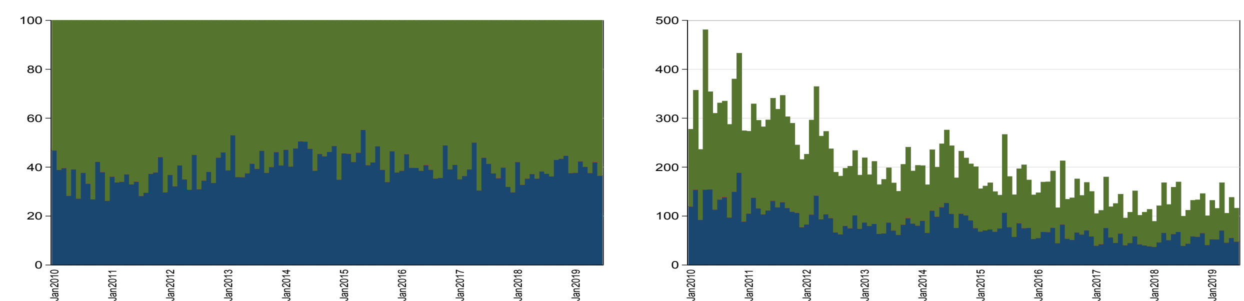


Figure A.9. Duration-adjusted monthly average gross and net positions by contract currency. Left column: percent of duration-adjusted monthly average gross notional of new positions in single-name and index contracts by contract currency; right column: duration-adjusted monthly average net notional of new positions in single-name and index contracts by contract currency. Notionals measured in USD billion-equivalents; positive net notional indicates net buying of protection.

(a) Single name | **(b)** Single name



(c) Index | **(d)** Index