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Network analysis using EMIR credit default swap data: Micro-level evidence from Irish-domiciled special purpose vehicles (SPVs)[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS or the central banks and other institutions represented at the meeting.

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Micro-level evidence from Irish domiciled special purpose vehicles (SPVs)

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Abstract

This paper analyses European Market Infrastructure Regulation (EMIR) trade repository data on credit default swaps (CDS) reported by a sample of domestic counterparties in Ireland. Using network analysis techniques, we explore to what extent these micro-level data can be used to improve regulators' understanding of the topology of the CDS network in Ireland. Despite data quality issues such as lack of information regarding duplicate trades and reference entities, we observe significant interconnectedness and concentration in the Irish CDS market. In particular, we focus on the derivative activities of special purpose vehicles (SPVs) as they are a key component of the shadow banking system. We identify SPVs who are net sellers of CDS contracts with linkages to regulated, non-domestic monetary financial institutions (MFIs). Overall, our analysis points to the importance of access to good quality micro-level regulatory data when monitoring financial stability risks.

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1. Introduction

The global financial crisis highlighted the lack of transparency in the over-the-counter (OTC) derivative market and, in particular, the credit default swap (CDS) market. When the U.S. based investment bank Lehman Brothers collapsed in 2008, the lack of information on privately negotiated derivative contracts coupled with their complexity significantly increased uncertainty and counterparty credit risk. The inclusion of this previously discounted risk factor into market participants' models resulted in a sharp decline in market liquidity and led to contagion across a range of financial markets. Owing to these developments, G20 leaders agreed at the September 2009 summit in Pittsburgh that all OTC derivative contracts should be reported to a trade repository (TR) and that all standardised OTC derivative contracts should be cleared through a central counterparty (CCP).[2]

The European Union regulation on derivatives, central counterparties and trade repositories, the European Market Infrastructure Regulation (EMIR) introduces new reporting requirements to improve market transparency and reduce the risks associated with the derivatives market. The new regulation came into force in 2012 and requires counterparties that enter into any form of derivative contract to report transaction-level information to a TR.[3] EMIR provides an opportunity for regulators to map the OTC derivative market to monitor financial stability risks.

Financial counterparties (FCs) and non-financial counterparties (NFCs) are within scope of EMIR for reporting requirements.[4] Both parties to a derivative transaction must report the transaction to a TR.[5] There are three main additional requirements for NFCs engaging in derivative activity above a certain threshold (referred to as NFC+'s) and all FCs, although only one is currently in force (Nov. 2015).[6] They are required to mark-to-market or mark-to-model their outstanding positions on a daily basis and they shall be required to clear certain classes of

2 Central counterparties are authorized entities which provide three main functions: clearing, settlement and custody.

3 The reporting obligation for all asset classes began on 12 February 2014 and the clearing obligation for standardised products has yet to commence. There are six trade repositories currently registered with ESMA in accordance with EMIR. DTCC Derivatives Repository Ltd., Krajowy Depozyt Papierow Wartosciowych S.A, Regis-TR S.A., UnaVista Limited, CME Trade Repository Ltd., and ICE Trade Vault Europe Ltd.

4 Financial counterparties are defined in Article 2 (8) EMIR as credit institutions, investment firms, investment funds (i.e. UCITS and alternative investment funds (AIFs)) or their management companies, institutions for occupational retirement provision (IORPs), and undertakings in insurance, assurance, and reinsurance. Non-EU AIFs are also included in this definition if their manager is authorised or registered in the EU. Non-financial counterparties are defined in Article 2 (9) EMIR as an undertaking established in the EU other than a CCP or a financial counterparty. These include small and medium-sized enterprises.

5 One party can delegate their responsibility to the other counterparty. Where a clearing obligation exists, the trade can be reported by a CCP on behalf of both entities involved.

6 EMIR introduces thresholds for the purpose of the clearing obligation. Based on gross notional values, the clearing thresholds for OTC derivatives are €1 billion for credit and equity derivatives and €3 billion for interest rate, foreign exchange, commodity derivatives, and other derivatives. If a firm or an undertaking surpasses one of these thresholds, they must inform ESMA and their regulator immediately. They must maintain their position above the threshold for a period of thirty working days to trigger the clearing obligation and they will then become a NFC+. If a firm or an undertaking exceeds one threshold for a particular derivative class, then they must clear all other classes of derivatives.

standardised derivatives such as plain vanilla interest rate swaps and CDS contracts through a central counterparty (CCP), and to apply risk mitigation techniques for derivatives that are not centrally cleared (e.g. post bilateral margins).[7]

Previous academic studies suggest that non-bank financial institutions play an important role in the market structure of the European CDS market (Clerc *et al.*, 2014). Motivated by this literature, we seek to examine whether micro-based EMIR data can be used to improve regulators' understanding of the topology of the CDS network in Ireland and to see if it can illustrate the activities of one sub-group within the financial sector, special purpose vehicles (SPVs). We note the limitations of the EMIR dataset (due to quality of reporting issues) and rather than focus too heavily on the full market network, we drill down into the SPV sub-sector as a case study of the financial system. SPVs are involved in a range of activities including securitisation, loan origination, and other financial activities. They are included under the measure of shadow banking applied by Ireland for the Financial Stability Board's Annual Monitoring Report 2015.[8] Interestingly, SPVs are currently classified as NFCs under EMIR. We analyse their activity within the EMIR dataset to see if the classification of SPVs as NFCs is appropriate.

This paper adds to the growing literature on financial networks and systemic risk. We extend the existing literature by focusing specifically on the Irish CDS market and on the CDS positions of shadow banking entities (SPVs) and their counterparties. Similar to the findings of Peltonen *et al.* (2014), we observe a scale-free degree distribution in the Irish CDS network whereby a high concentration of links exists amongst a core of several non-domestic monetary financial institutions (MFIs) and other financial intermediaries (OFIs) while other counterparties on the periphery transact with only a few nodes.[9] In addition, our analysis of micro-level data identifies SPVs as large net sellers of CDS contracts to non-domestic MFIs. These SPVs are components of the shadow banking sector in Ireland and are subject to limited regulatory oversight relative to, for example, collective investment schemes (Godfrey *et al.,* 2015). In terms of policy implications, our analysis points to the importance of incorporating new micro-level data when assessing potential sources of financial stability risk.

7 Central clearing of CDS, when implemented, may alleviate some of the counterparty risk externalities in OTC markets as the risk is centralised into the CCP (Acharya and Bisin, 2011).

8 The FSB (2014) defines shadow banking as *"credit intermediation involving entities and activities fully or partially outside of the regular banking system."*

9 A scale-free degree distribution follows a power law distribution where a few major nodes (hubs) are connected to a large number of nodes who have only a few connections themselves. Examples of a scale-free distribution in real-world networks are the internet and social networks. Links are also known as edges in the network literature. Monetary financial institutions (MFIs) are credit institutions, non-credit institutions (primarily money market funds), national central banks, and the ECB whose business takes deposits from entities other than MFIs and provides credit and/or investments in securities (ECB, 2015a).Other financial intermediaries (OFI) are corporations or quasi-corporations, except for insurance corporations and pension funds, that engage primarily in financial intermediation by way of incurring liabilities in forms other than currency, deposits, and/or close substitutes for deposits from institutional entities other than MFIs (ECB, 2015a). They include in particular those engaged primarily in long-term financing, such as corporations engaged in financial leasing, financial holding corporations, dealers in securities and derivatives (when dealing for their own account), venture capital corporations and development capital companies. As financial vehicle corporations (FVCs) and other SPVs typically engage in financial intermediation, they are normally included in the definition. However, for the purposes of this paper, we treat FVCs and other SPVs collectively as SPVs and separate them from other OFIs.

The rest of the paper is structured as follows. Section 2 discusses the role of CDS contracts during the financial crisis and situates our work within the existing literature. Section 3 presents the EMIR TR data used in our analysis and introduces the network analysis techniques applied. The results of our network analysis are presented in Section 4 along with a brief discussion on interconnectedness and potential systemic risks. Section 5 concludes.

2. The role of the CDS market during the financial crisis

2.1 Credit default swaps explained

A credit default swap (CDS) is an over-the-counter (OTC) credit derivative that protects the buyer against loss of principal (known as the notional) due to a specified reference entity experiencing a credit event (Mengle 2007).[10] In return for this protection, the buyer pays a periodic premium to the seller (known as the spread) until the end of the contract. If the reference entity experiences a credit event, the protection buyer can claim payment from the seller minus the recovery value of the underlying asset. CDS contracts were widely used prior to the crisis due to their liquidity relative to the reference entity's bonds, and their leverage (which enables large positions with little capital investment). CDS contracts and other derivatives were also used as hedging tools to reduce a bank's required regulatory capital or as part of a tax or accounting strategy to alter the treatment of a particular asset (Gregory 2012).

2.2 The role of the CDS market during the global financial crisis

Many factors contributed to the global financial crisis.[11] CDS exposures contributed to the propagation of shocks across financial markets and borders. As noted by the EU Commission (2009 p. 5):

> The near-collapse of Bear Sterns in March 2008, the default of Lehman Brothers on 15 September 2008 and the bail-out of AIG on 16 September highlighted the fact that OTC derivatives in general and credit derivatives in particular carry systemic implications for the financial market.

The opaqueness of the OTC derivative market, whereby information on privately negotiated contracts was only available to the contracting parties, engendered a great deal of uncertainty among market participants (Coudert and Gex, 2011). Systematic risk in the CDS market arises from the leverage and the concentration of positions in a few financial counterparties. This uncertainty coupled with the systematic risk in the CDS market served to significantly increase

10 A credit event typically occurs when the there is a default or some other activity, such as a restructuring of debt, which effects the market value of the reference entity's debt.

11 Reinhart and Rogoff (2009), Brunnermeier (2009), and Taylor (2009) provide succinct analyses of the global financial crisis.

counterparty credit risk in the financial system.[12] For example, in 2008 Lehman Brothers had almost half a trillion dollars' worth of CDS contracts written against its debt and held around 1.5 million CDS positions with around 8,000 unique counterparties while maintaining a single A credit rating (Gregory, 2012).

The collapse of two major CDS market participants in close succession made other participants acutely aware of their exposure to counterparty credit risk, leading to a flight to less risky assets and contagion in other markets. The high degree of interconnectedness in the CDS market made it more vulnerable to common shocks in the financial system and substantially increased the probability of systemic default risk (i.e. the probability that several financial institutions default simultaneously) as noted by Giglio (2011). Further compounding these factors was the failure of counterparty risk mitigation methods (e.g. posting collateral) and the failure of SPVs to function as intended (Gregory, 2012). The bailout of AIG illustrates the ease with which counterparty risk transforms into systemic risk. As a result, counterparty credit risk was at the centre of the regulatory response to the global financial crisis.

Arora *et al.* (2012) sets out the three main sources of counterparty credit risk in the CDS market. The first source of counterparty credit risk is the risk that the CDS seller is undercapitalized in the event of a credit event. The second risk is the risk that the CDS seller becomes insolvent and the buyer becomes a general unsecured creditor of the CDS seller. The third risk is the risk of a CDS buyer losing their claim on collateral posted by the seller in the event that the seller becomes insolvent and the collateral has been rehypothecated to another CDS buyer.

An additional source of counterparty credit risk is wrong-way risk, which arises when reference entities and sellers of CDS contracts become strongly correlated. It is when the credit quality of a reference entity is tied to that of the CDS counterparty's ability to pay (i.e. the exposure to the reference entity is high when the counterparty is more likely to default). Wrong-way risk is exacerbated in the CDS market due to the high level of concentration of counterparties and the common industry practice of using offsetting transactions. Peltonen *et al.* (2014) note that the CDS market is highly concentrated and dominated by financial counterparties. ECB (2009) suggest that the global financial crisis has further increased market concentration owing to the exit of some major CDS players such as Bear Stearns, Merrill Lynch, and Lehman Brothers. Further increasing wrong-way risk, the most traded CDS contracts have reference entities in the financial sector and this leaves the market vulnerable to double defaults. The case of Lehman Brothers illustrates the systemically destabilising effects of the default of both a major CDS dealer and a highly traded reference entity (Coudert and Gex, 2011). Furthermore, CDS market participants usually terminate positions or hedge their counterparty credit risk by entering into another transaction that has the opposite sign. These offsetting transactions reduce an individual counterparty's net exposure, but collectively create a complex web of exposures that ultimately increases counterparty credit risk. Counterparty risk mitigation techniques (i.e. bankruptcy remote vehicles and collateral) can themselves create other types of risk such liquidity, legal and operational risks (Gregory, 2012).

[12] According to Thompson (2010), counterparty credit risk can be defined "*as the risk that when a claim is made, the insurer will be unable to fulfil its obligations*."

Entrusted with the mandate of financial stability, regulators are responsible for mitigating counterparty credit risk as a component of systemic risk. A large body of literature has emerged since the global financial crisis focusing on the identification, measurement, and modelling of systemic risk. Systemic risk is jointly identified by the IMF, BIS and FSB (2009) as a risk of disruption to financial services that is caused by an impairment of all or parts of the financial system and has the potential to have serious negative consequences for the real economy. Of particular importance to regulators is the form of systemic risk that destabilises the financial system and precipitates macroeconomic downturns. Bisias *et al.* (2012) offers a comprehensive review of the landscape of tools designed to model this form of systemic risk. Our paper contributes to the growing literature on systemic risk by using network analysis as a tool to examine the interconnectedness of the Irish CDS market with particular emphasis on SPVs drawing on new regulatory data on derivative positions of Irish domiciled entities.

3. Data and network analysis

3.1 Data cleaning

As the EMIR trade repositories' databases are a new source of data, we outline in this section how we prepare the data and the limits of our dataset. EMIR trade repository data contain information on a CDS transaction's type, counterparties and reference entities along with other characteristics. In order to map the interconnectedness of the Irish CDS market, we use trade repository data reported under EMIR by a sample of Irish domiciled entities on 1 September 2015. These data are based on outstanding CDS transactions drawn from the six registered trade repositories.

Our raw sample contains 260,928 transactions. However, over 234,000 of these transactions involve two non-Irish counterparties trading in CDS contracts with a bespoke index or basket listed as the reference entity.[13] On this basis, we exclude these transactions from our initial dataset, which reduces to 26,294 positions. The dual reporting obligation of EMIR provides two reports of the same trade and we match and remove duplicate trades.

Our procedure for matching duplicate trades is as follows: first, we separate the European Economic Area (EEA) from the non-EEA transactions using the 'Trade with non-EEA counterparty' field (the latter will not have a matching trade as they are not required to report). Our initial dataset contains 19,328 trades between two EEA counterparties and 6,966 trades between EEA and non-EEA counterparties. Second, we rely primarily on the unique trade identifier (UTI) along with the contract's fundamental characteristics (i.e. counterparties and their trading capacities, notional values, reference entities, and maturity dates) to match the EEA trades. We find 6,449 CDS contracts that are reported by both counterparties using this method. In addition, we utilize the distribution of the notional amounts to discover 450

[13] TRs send these transactions to the Central Bank of Ireland as it cannot be surmised if the underlying reference entity is of Irish domicile.

positions with two different UTIs but the same fundamental characteristics.[14] Despite being able to pair 6,899 trades, we are unable to match 5,530 transactions as they are linked to only one UTI and have a notional amount that appears once or more than twice.[15] These trades may represent counterparties choosing different UTIs for the same contract or could indicate that the other counterparty has not yet reported the trade. Adding back in the non-EEA transactions, we arrive at a reduced sample of 19,395 unique CDS contracts. Unique trade identifiers provide a good starting point for identifying duplicate trades, but our analysis underscores the need for ensuring that each trade has one UTI and that the counterparties to a trade consistently populate this field with the same value.[16]

Prior to conducting our network analysis on the remaining 19,395 unique CDS contracts, we clean the data by examining the notional values for outliers and exclude transactions with unidentifiable values for counterparties and missing reference entities. Following Peltonen *et al.* (2014), we exclude 202 trades with gross notional values below €1,000 as this may reflect misreporting. After the removal of these outliers, we are left with €117.1 billion in gross notional. We are unable to identify 24 counterparties so we exclude the 232 CDS contracts attached to them. There are 3,858 trades that are omitted because they contain either no value or a placeholder value for the reference entity. Our total exclusions include 4,292 transactions. We see our final dataset as a sample rather than the full population.

3.2 Data categorisation and the netting process

As illustrated in Table 1 below, the cleaned dataset includes 15,103 unique CDS contracts reported by Irish domiciled companies on 1 September 2015. There are 373 counterparties or nodes in our sample that hold 1,875 bilateral positions with one another on 897 global reference entities. Due to inconsistencies of self-reporting in the EMIR data (see Annex 1) we divide the counterparties into 6 entity types: MFIs, OFIs (not including SPVs), SPVs, insurance companies (ICs), pension funds (PFs), and non-financial corporations (NFCs).[17] Counterparties trade in the CDS market with notional amounts denominated in nine different currencies: EUR, GBP, USD, JPY, AUD, IDR, COP, BRL, and NOK. Gross notional values are generally seen to overstate the actual levels of risk in the CDS market. This is because counterparties typically offset purchase and sale transactions to reduce their net exposures and thus their credit risk. Net notional values represent the net exposure

14 We pair trades with only two transactions for a specific notional amount as long as they have the same counterparties trading in the same capacity, the same reference entity, and the same maturity date.

15 We found over 500 transactions that have the same trade identifier, but have different underlying characteristics. We treat these transactions as unique contracts as they cannot be reliably identified as a pair by any of the other characteristics.

16 In addition, the 'Action type' field would greatly assist regulators in identifying duplicate trades as it identifies trades as new, modifications, cancellations, or valuation updates. In our dataset this field is generally left blank.

17 MFIs, ICs, PFs and OFIs are identified on financial regulator or central bank registers where relevant; SPVs are identified through the ECB register of FVCs or through the Central Bank of Ireland internal database if not found through these sources, all other entities are identified through publicly available information. Non-financial corporations are corporations or quasi-corporations that are not engaged in financial intermediation, but mostly produce goods and non-financial services (ECB, 2015b).

between CDS sellers and buyers. A caveat to this approach is that in liquidation, a counterparty may not offset positions; they may manage their claims in a more strategic manner. For the netting process, we are assuming that all counterparties follow the International Swaps and Derivatives Association (ISDA) Master Agreement and make good on the claims against them.[18]

Our netting process begins by rolling counterparties up to the counterparty family or holding group level (as outlined by DTCC, 2011). This changes the entity type for some of the nodes (e.g. an OFI may become a MFI at the group level). We then estimate the net notional value by offsetting purchase and sale positions by counterparty pair for each reference entity to arrive at one net buyer or net seller. There are 2,419 trades with unspecified reference entities and therefore we are unable to net these transactions owing to a lack of information on the specific index or basket underlying the contract.[19] Excluding these transactions removes approximately €37.4 billion in gross notional from our sample (almost half the gross notional in our sample dataset).[20] We net the remaining 12,431 unique CDS contracts with a gross notional value of €50.8 billion.[21] The number of contracts falls to 4,598 and the notional falls to €40.0 billion. This represents a net-over-gross notional ratio of 78.7 per cent. The ratio is high in comparison to other empirical papers.[22] This may be due to the netting process or to data quality issues as mentioned above.[23]

Next, we construct a sub-sample of derivative transactions reported by SPVs domiciled in Ireland. In total, there were 451 transactions reported by Irish domiciled SPVs. SPVs provide a useful case study for the examination of transaction-level CDS data as they are currently classified as NFCs under EMIR. While our sub-sample of SPVs is small (see Table 1), the network based on these data provides a useful insight into some of the OTC derivative activities of shadow banking entities.

18 The ISDA Master Agreement is used as a basis for most market participants' OTC derivatives contracts to dispel any legal uncertainties that may arise and to provide defined methods for mitigating counterparty risk. It specifies the general terms of the bilateral agreement with respect to, among other things, netting, collateral, and the definition of default and other termination events. The Master Agreement also ensures closeout netting in the event of a counterparty's default. Closeout netting allows for the immediate termination of all outstanding contracts between a counterparty and a defaulted institution and for the offsetting of the amount that is owed by each counterparty to each other to arrive at a single net payment to one counterparty. This process is favoured by market participants because it allows the surviving institution to immediately realise its gains against its losses on its positions with the defaulted counterparty and to place itself first in the bankruptcy queue for receiving its net payment (assuming its gains exceed its losses). See chapter 4 of Gregory (2012) for a more detailed discussion.

19 EMIR allows counterparties to enter an 'I' or a 'B' as the reference entity when the index or basket does not have a unique identifier such as an ISIN.

20 The breakdown of the figure is 2,299 indices with €33.4 billion in notional and 120 bespoke baskets with €4.0 billion in notional.

21 We remove 15 compression trades as these will become redundant once the netting is complete. Compression trades are multilateral netting agreements typically executed by a third party that reduce the number of trades and the gross notional amounts into a net notional position while maintaining the same risk profile of the trades.

22 Peltonen *et al.* (2014) compute a net-over-gross notional ratio of 8.2 per cent.

23 This is a further caveat of our results. We consider our results therefore as a sample of entity type interconnectedness rather than a presentation of the complete CDS network.

Our network analysis of derivative transactions is subject to a number of limitations. First, our dataset is a sub-sample of derivative transactions which renders our network incomplete. Network analysis of derivative positions of entities at a European or global level would allow for a more detailed analysis of systemic risks and the potential implications for financial stability. Second, our analysis includes outstanding derivative transactions on 1 September 2015 and therefore provides a snapshot of the CDS market topology at this point in time. Time-series data would allow for a more detailed analysis of the changing topology of the Irish CDS market. Third, as highlighted by Clerc *et al.* (2014), further information on netting and collateralisation would be required in order to assess fully the potential contagion paths and financial stability risks in the CDS market. Fourth, as detailed above, we observe significant data quality issues within our sample which restricts our network analysis. Many of the data limitations we experienced have also been highlighted by the FSB (2015) in their recent review of EMIR. Owing to these data availability and reporting issues, our network measures and results should be interpreted with a degree of caution.

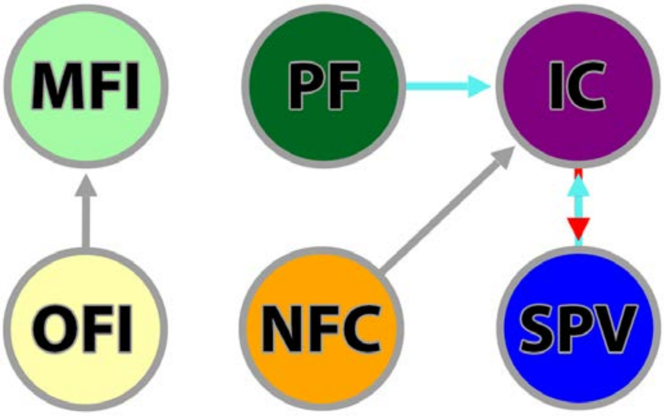
3.3 Network analysis

Network analysis allows researchers and regulators to map the interconnectedness of derivative transactions and their possible contagion paths. It also aids the understanding of systemic risk across a range of financial systems and sectors (Haldane, 2009; Bech and Atalay, 2010; Minoiu and Reyes, 2013; Clerc et al., 2014; Alves et al., 2015). From a regulatory and policy perspective, network analysis can be utilised to take a macro-view of a particular market in order to examine the topology of a network.

In our analysis, each counterparty to a CDS transaction is a node in the network. For example, if a SPV enters into a derivative transaction with a MFI, both the SPV and the MFI are listed as nodes in our network. Links between nodes are weighted and represent the sum of either the net value of CDS purchases or sales across one or several transactions. In line with previous studies in the literature, the links between nodes in our network are also directional (from the buyer of the CDS contract to the seller). If the arrow points towards the node, this indicates that the node is a net bilateral seller. Chart 1 illustrates these network analysis concepts.

Network Analysis Conventions

Chart 1



Note: We colour the nodes based upon the institution's publicly available industry classification. Light green nodes are MFIs, yellow are OFIs, dark green are PFs, purple are ICs, orange are non-financial corporates (NFCs), and blue are SPVs. The arrow pointing towards a node indicates that it is a net bilateral seller of CDS contracts for one or several reference entities. The arrow pointing away from a node indicates that it is a net bilateral buyer of CDS contracts from another node. The colour of the link represents the value of the sum of either the net bilateral buying positions or the sum of the net selling positions. Grey arrows are positions below €100 million, red are equal to or above €100 million and below €1 billion, and light blue are equal to or above €1 billion. Node size is proportional to the total exposure. As shown in Chart 1, the OFI is a net bilateral buyer of CDS contracts from the MFI. The net bilateral buying position is below €100 million (as indicated by the grey link) and represents the sum of the net buying positions across reference entities. The MFI only sells CDS contracts to the OFI and does not buy CDS contracts from any other node. The IC has a net bilateral selling position with the PF and the SPV for equal to or above €1 billion (light blue link). It also is a net seller of CDS contracts to the NFC for below €100 million (grey link). The IC is a net buyer of CDS contracts from the SPV for equal to or above €100 million and below €1 billion (red link). So it holds both a net bilateral buying position and a net bilateral selling position with the SPV. Just to note, the net multilateral position would be arrived at by offsetting the net bilateral buying position against the net bilateral selling position. The net multilateral positions are not shown on our graphs, but they are discussed in the results section (Table 3).

There are a growing number of academic studies which employ network analysis techniques in the economics and finance literature. For example, Minoiu and Reyes (2013) assess the dynamics of the global banking network using data on cross-border banking activities for 184 countries from 1978-2010. In an earlier study, Bech and Atalay (2010) explore the network topology of the federal funds market with banks acting as nodes and loans from one bank to another as the directed links. A small but growing literature has applied network analysis techniques to the CDS market. For example, Peltonen *et al.* (2014) show how the global CDS market has similar properties to the interbank market and is concentrated around fourteen major dealers. Clerc *et al.* (2014) examine the European CDS market structure and find that some non-bank financial counterparties are important players while Alves *et al.* (2015) employ network analysis techniques to examine the linkages of EU insurance groups.

We analyse our network based on a number of commonly used indicators. We first consider two simple measures of degree centrality: *degree* and *strength*. We compute *in-degree* as the number of incoming links which corresponds to nodes that are net bilateral CDS sellers. *Out-degree* is based on the number of outgoing links and represents nodes that are net bilateral CDS buyers. Adding up *in-* and *out-degree* yields the *degree* or the total number of net bilateral exposures. To capture the size of these net exposures, we use *strength*. *In-strength* represents the sum of the net bilateral selling positions with other counterparties while *out-strength* is estimated by summing the net bilateral buying positions.

Two common measures used in the literature to represent a node's interconnectedness are betweenness centrality and eigenvector centrality. *Betweenness centrality* can be used to measure how often a node appears on the shortest path between nodes in the network *(*Freeman, 1979). It allows the identification of major hubs in networks. *Eigenvector centrality* measures the importance of a node within a network by measuring the number of counterparties that are directly exposed to it and also takes into account all of the other counterparties that are indirectly exposed to a node through their links with these counterparties. Eigenvector centrality could be used to pinpoint systemically important nodes.[24] We normalise betweenness (to the betweenness index) and eigenvector centrality (to eigenvector centrality score) to ensure comparability across networks.

4. Results

4.1 CDS network visualisations

Chart 2 displays the gross notional position of the Irish CDS network at 1 September 2015. In terms of connectivity, we see that the network is quite concentrated with a number of key nodes at its core. The most connected nodes are seven non-domestic MFIs and one non-domestic OFI. As expected, these nodes are G16 dealers (i.e. the largest 16 derivative dealers worldwide, see Clerc *et al.* 2014 for the specific institutions) and globally systemically important banks (G-SIBs) with linkages to over a hundred counterparties.[25] The largest two dealers in the centre of the network are linked to 150 and 142 unique counterparties respectively. The circle of nodes outside the inner core of dealers is comprised of companies with a degree between ten and a hundred and nodes with less than ten links are on the perimeter of the network. The former group has one MFI and two OFIs with large CDS exposures (as denoted by the larger node size relate to their degree cohort). The majority of SPVs are on the outer layer of the network and do not appear to be highly interconnected players in the overall CDS network in Ireland. We do, however, observe a couple of MFIs and SPVs in the periphery of the network with few linkages but large total exposures.

Chart 3 examines the Irish CDS network after we introduce our netting procedure. We note that the number of nodes in the network falls owing to the merging of counterparties into group level as part of the netting process and due to perfectly offsetting positions. This illustrates the degree to which netting reduces risk in the CDS market and is consistent with the findings in the literature. The net network has mainly the same highly interconnected nodes as in the gross notional network.[26] Again, the majority of SPVs in the net network are in the outer layer. The

[24] Eigenvector centrality is defined mathematically as $\lambda v = Av$ where A is the adjacency matrix of the network graph, λ is a constant known as the eigenvalue, and v is the eigenvector of degree centrality. The x times x adjacency matrix (where x is the number of nodes) is formed by assigning a 1 to a node pair if there is a link between them and a 0 if there is no link. The eigenvector is a x times 1 vector containing each node's degree centrality.

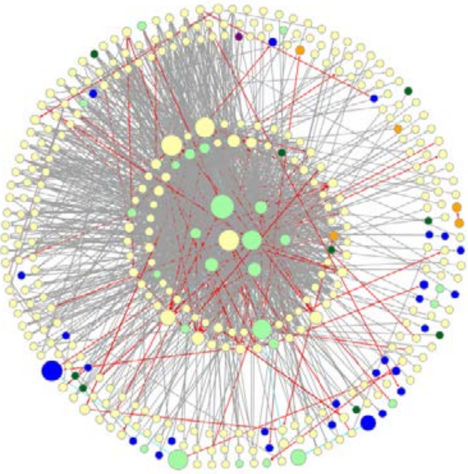
[25] The FSB releases an annual list of globally systemically important banks (FSB 2015b).

[26] The OFI in the gross network becomes a MFI in the net network due to netting based on counterparty family level.

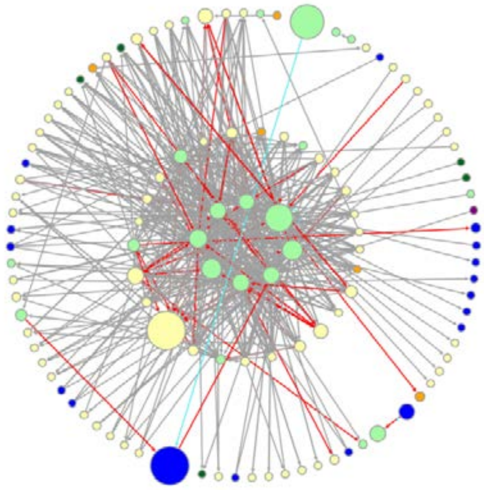
MFIs and SPVs identified on the periphery in the gross network remain in the same place in the net network, but their net CDS exposures are relatively larger than the inner core of dealers. We also observe a reduction in the number of OFIs with significant exposures in the middle circle of the net network.

Irish CDS Network

Gross Notional Outstanding Chart 2



Net Notional Outstanding Chart 3



Source: EMIR data from 1 September 2015 and authors' calculations.

4.2 Descriptive statistics

Table 1 displays the topology of the three networks: the gross, the net, and the net SPV network. Looking at the net networks, Irish domiciled institutions hold buying or selling positions in CDS contracts with, on average, five other counterparties while SPVs typically hold their positions with one other counterparty. The mean in- or out-strength in the net CDS market is €341.9 million (Table 1) whereas for the SPV network it is €401.6 million.[27] We note that the nodes in the Irish CDS network follow a fat-tailed (power law) degree distribution (similar to Clerc *et al.,* 2014 and Peltonen *et al.,* 2014).[28]

27 Comparing SPVs' contracts to NFCs' contracts, we note that NFCs trade with on average 2 counterparties with an in- or out- strength of €40.5 million.

28 This implies that a small number of counterparties are exposed to a large number of counterparties but the majority of counterparties are exposed to only a few counterparties. Using the Kolmogorov-Smirnov test, we fail to reject the null that the degree distribution follows a power law distribution at the 1 per cent significance level.

Topology of the Irish CDS Market

Table 1

	Gross	Net	Sub-Sample of Irish SPVs (Net)
Nodes	373	117	30
Links	1,875	619	36
Unique CDS Trades	15,103	4,598	360
Reference Entities	897	846	328
Density	1.4	4.6*	4.1*
Mean In- or Out-Degree (no. of links)	5.0	5.3	1.2
Mean In- or Out-Strength (size of link, €m)	238.2	341.9	401.6

Source: EMIR data from 1 September 2015 and authors' calculations. * Indicates that these density measures (ratio of actual to possible links) are high relative to other studies. In 2011, Clerc *et al* (2014) observe a density of 0.6 per cent for European reference entities and Peltonen *et al.* (2014) calculate a density of 0.5 per cent for global reference entities.

Table 2 below shows the top-10 counterparties in the Irish CDS market. For out-strength, G16 dealers are more present at the top of the rankings as there are three in the top five. There is only one G16 dealer ranked fifth out of the top ten institutions by net multilateral selling position, thereby corroborating the finding in the literature that the G16 dealers or the G-SIBs engage in a great deal of netting and have correspondingly low multilateral positions (Peltonen *et al.*, 2014 and Clerc *et al.*, 2014). The nodes with the largest in-degree are MFI 5 and MFI 12 who trade with 38 counterparties. Meanwhile, the nodes with the largest out-degree is MFI 6 who trades with 37 counterparties. The top nine nodes by in-degree are G16 dealers and G-SIBs as are the top eight by out-degree. These different metrics provide valuable supervisory information for the identification of risks to the financial system.

Top-10 counterparties in the Irish CDS market

Table 2

Rank	In-degree		Out-degree		In-strength (€ m)		Out-strength (€ m)		Net multilateral selling position (€ m)		Eigenvector centrality score	Betweenness index
1	MFI 5*	38	MFI 6*	37	OFI 22	8,548.2	OFI 16	7,349.6	OFI 22	8,390.1	MFI 5*	MFI 5*
2	MFI 12*	38	MFI 5*	35	SPV 19	8,268.3	MFI 5*	3,466.0	SPV 19	7,808.9	MFI 12*	MFI 10*
3	MFI 6*	36	MFI 41*	31	MFI 5*	2,222.4	MFI 9*	2,564.1	OFI 18	1,924.1	MFI 41*	MFI 6*
4	MFI 10*	34	MFI 12*	29	SPV 63	2,049.3	MFI 41*	2492.5	SPV 63	1,804.2	MFI 6*	MFI 12*
5	MFI 41*	32	MFI 10*	28	OFI 18	1,944.8	MFI 13	2,049.3	MFI 30*	565.2	MFI 9*	MFI 41*

6	MFI 7*	31	MFI 9*	28	MFI 12*	1,444.6	OFI 1	1,736.0	NFC 54	555.9	MFI 7*	MFI 7*
7	MFI 9*	30	MFI 8*	28	MFI 7*	1,172.6	MFI 12*	1,574.0	SPV 59	506.6	MFI 3*	MFI 8*
8	MFI 8*	27	MFI 3*	27	MFI 41*	1,097.6	MFI 8*	1,554.4	OFI 20	336.4	MFI 8*	MFI 9*
9	MFI 3*	26	OFI 1	18	MFI 10*	1,087.8	MFI 6*	1,494.1	OFI 46	239.0	OFI 22	OFI 22
10	OFI 22	14	OFI 4	13	MFI 6*	966.2	MFI 10*	1,484.4	OFI 23	89.0	MFI 10*	MFI 3*

Source: EMIR data from 1 September 2015 and authors' calculations. * Indicates the institution is a G-SIB and a G-16 dealer.

Table 3 displays the net multilateral positions and market shares of each sector in the Irish CDS market.[29] OFIs and SPVs are the dominant market participants on the sell side, holding a combined 93.2 per cent of the outstanding net multilateral positions in the market. On the buy side, we see MFIs as the largest market participant with a 78 per cent market share while OFIs represent 20.2 per cent of the market. In particular, we find ten SPVs holding net multilateral selling positions totalling €10.3 billion and seven SPVs are net multilateral buyers of CDS contracts for a total of €262.6 million in net notional. With regard to the distribution of net multilateral positions, the Irish CDS market is comprised of 61 per cent CDS contract buyers and 39 per cent CDS contract sellers, in comparison to the European CDS market, which is made up of 18 per cent net multilateral sellers and 82 per cent buyers according to Peltonen *et al.* (2014).

Net Multilateral Positions and Market Shares by Sector

Table 3

Sector	Net multilateral selling position (€ m)	Market share (%)	Sector	Net multilateral buying position (€ m)	Market share (%)
OFI	11,178.7	48.5	MFI	17,978.1	78.0
SPV	10,317.4	44.7	OFI	4,652.4	20.2
MFI	889.4	3.9	SPV	262.6	1.1
NFC	625.5	2.7	NFC	126.4	0.5
PF	47.1	0.2	IC	20.7	0.1
			PF	18.1	0.1

Note: EMIR data from 1 September 2015 and authors' calculations.

Overall, our network metrics suggest that the Irish CDS market is small and concentrated amongst a few key players while counterparties appear to be highly

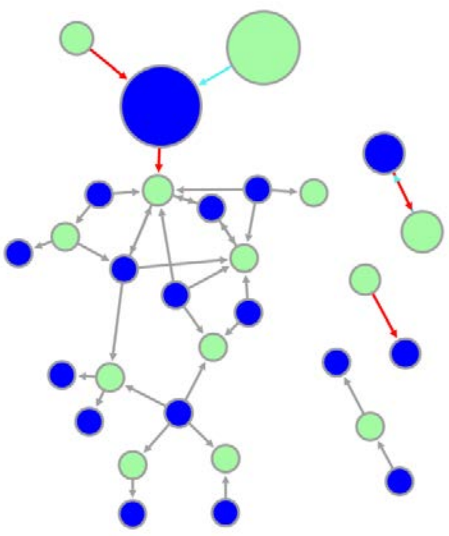
29 The net multilateral position is estimated by offsetting the net bilateral buying position against the net bilateral selling position. Thus a net multilateral selling position indicates that once offset the entity is a net seller. Due to the high asymmetry of CDS returns, net sellers can carry a disproportionate share of systemic counterparty risk in the CDS market (Clerc *et al.,* 2014). This risk can be intensified by inadequately capitalised protection sellers (Cont and Minca, 2014).

exposed to individual nodes reflecting a scale-free network. According to Callaway *et al.* (2000), scale-free networks are strongly resilient to the failure of any particular node. Therefore, if an institution were to fail, the probability of it being a dealer is small given the existence of a large number of nodes with low degree centrality. Even if a dealer or a hub were to fail, the CDS network structure and connectivity would largely remain intact due to the presence of the other dealers. However, the Irish CDS network is vulnerable to the simultaneous failure of a few major dealers, and it accordingly has the robust-yet-fragile property (Haldane 2009).

Next, we limit our network to a sub-sample of CDS transactions between SPVs and other counterparties. As shown in Chart 4, we observe significant interconnectedness between SPVs and non-domestic, regulated MFIs. While the network metrics employed in this paper point to a less interconnected network compared to the full sample of transactions, we see that some SPVs are net sellers of CDS contracts with a net notional of over €100 million and that these shadow banking entities are trading bilaterally with non-domestic regulated MFIs.[30] Given that these SPVs are subject to limited regulatory oversight, our analysis suggests that micro-based data such as EMIR trade repository data can be useful for examining potential contagion paths and risks to financial stability which may transmit from the shadow banking sector to the banking sector. In this light the categorisation of SPVs as NFCs in EMIR may need to be reviewed.

Irish CDS Network, Net Notional

SPVs Sub-Sample — Chart 4



Source: EMIR data from 1 September 2015 and authors' calculations.

[30] This finding has been independently verified through the EMIR unit in the Central Bank of Ireland.

5. Conclusion

This paper examines the Irish CDS markets using new derivative transaction data arising from the implementation of EMIR. We highlight some of the limitations of the EMIR transaction data as it currently stands and suggest improvements. Ensuring that all counterparties agree and populate the trade ID field, the reference entity field, and the action type field would greatly assist regulators in matching duplicate trades and in the netting process. Due to the current limitations in the data, we treat our final dataset as a representative sample rather than as the full population of transactions.

Our analysis finds that the Irish CDS market is small and concentrated. Similar to the findings of Peltonen *et al.* (2014), we observe a scale-free degree distribution in the Irish CDS network whereby a high concentration of links exists amongst a few non-domestic MFIs and OFIs. In addition, our analysis of micro-level data identifies a number of SPVs who are large net sellers of CDS contracts with significant linkages to regulated non-domestic MFIs. These SPVs are non-bank financial institutions, components of the shadow banking system in Ireland, and categorised as NFCs under EMIR. We conclude that EMIR transaction data can be used to highlight activity for further investigation by market supervisors. On the whole, our analysis points to the importance of incorporating new micro-level data when assessing potential sources of financial stability risks arising from the shadow banking sector.

Annex 1: Inconsistencies of self-reporting in the EMIR data

Taking an initial look at the gross data, we observe some inconsistencies in the self-reporting of companies as to whether they are a financial counterparty (FC) or a non-financial counterparty (NFC). As shown in Table 5, FCs represent 54.2 per cent of total derivative trades in our final sample with NFCs representing 10.5 per cent. Under EMIR, only the reporting counterparty has to provide their classification (or a third party on behalf of the counterparty), and they are not required to classify the other counterparty to the transaction. In 24.3 per cent of trades the other counterparty is not classified. For example, only 10 of the 31 SPVs with outstanding CDS positions were required to fill out their status and of these, 6 identified as NFCs, 3 as FCs, and 1 as both a FC and a NFC. In total 4.7 per cent of counterparties report as a FC in some transactions and as a NFC in others. The 'Corporate sector of the counterparty' field might supplement these inconsistencies and provide more information on the nature of the companies' activities, but it is unreported for many transactions. Therefore, we introduce our own classifications as set out below in section 4.2. These classifications are consistent with publicly available information and provide more insight into the functions of the companies involved in CDS transactions rather than the binary classification under EMIR (i.e. FC or NFC).

Classifications of counterparties and other counterparties in EMIR transaction data

Table 5

Classification	Percentage
Financial Counterparty	54.2
Non-Financial Counterparty	10.5
Financial & Non-Financial Counterparty	4.7
N/A (Always other counterparty)	24.3
Financial Counterparty & Blank	4.3
Financial Counterparty, Non-Financial Counterparty & Blank	1.0
Non-Financial Counterparty & Blank	0.8
Blank	0.2

Source: EMIR data from 1 September 2015 and authors' calculations. The other counterparty has no obligation to identify itself under EMIR, and N/A refers to counterparties that are always the other counterparty for all their transactions.

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Network analysis using EMIR credit default swap data: Micro-level evidence from Irish-domiciled special purpose vehicles (SPVs)[1]

Kitty Moloney, Oisin Kenny and Neill Killeen,
Central Bank of Ireland

[1] This presentation was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS or the central banks and other institutions represented at the meeting.

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Network analysis using EMIR credit default swap data: Micro-level evidence from Irish domiciled special purpose vehicles (SPVs)

Kitty Moloney Central Bank of Ireland*

IFC-NBP Workshop in Warsaw on 14-15 December 2015 - Session 4

- This presentation summarises the paper of the same title authored by Kitty Moloney, Neill Killeen and Oisin Kenny. The views expressed in this presentation are solely the views of the authors and are not necessarily those held by the Central Bank of Ireland or the European System of Central Banks (ESCB).

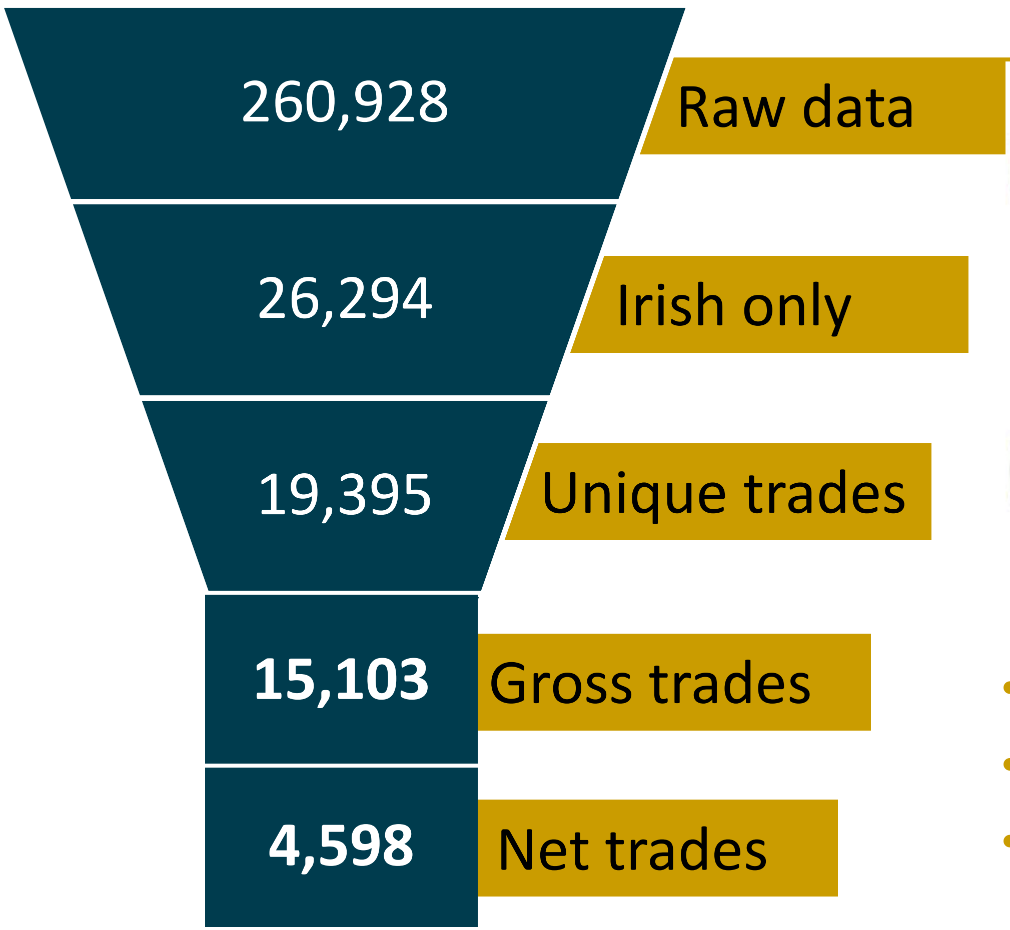
Objectives

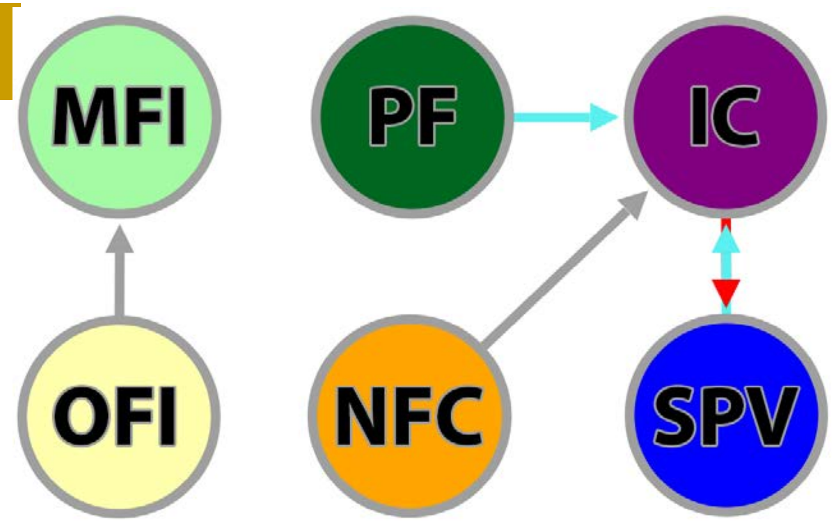
- Quantify EMIR data quality issues
- Analyse Irish CDS market and a sub-sample of SPVs
- Discuss financial stability implications

Literature Review

- ***Gregory (2012)*** *counterparty credit risk and the crisis*
- ***IMF, BIS, & FSB (2009)*** *define systemic risk:*
  - *The risk of disruption to financial services caused by an impairment of all or parts of the financial system with the potential for a large and negative impact on the real economy*
- ***Haldane (2009)*** *more regulatory focus on highly interconnected firms to avoid financial contagion*
- ***Minoiu & Reyes (2013)*** *global banking network*
- ***Clerc et al. (2014)*** *European CDS network:*
  - *Some non-bank financial companies are important players*
- ***Peltonen et al. (2014)*** *global CDS network*

Data Cleaning and Network Analysis Conventions





- Grey **edge:** below €100 m
- Red **edge:** between €100 m and €1 bn
- Blue **edge:** above €1 bn

Source: EMIR data from 1 September 2015 and authors' calculations.

Network Analysis Metrics

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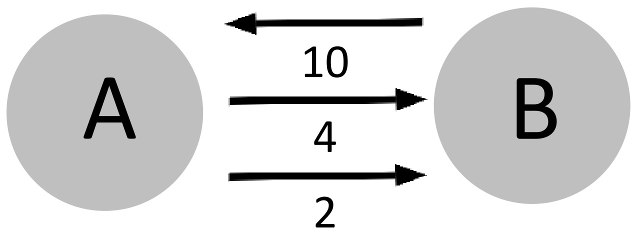
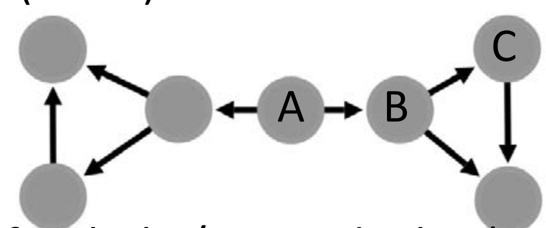
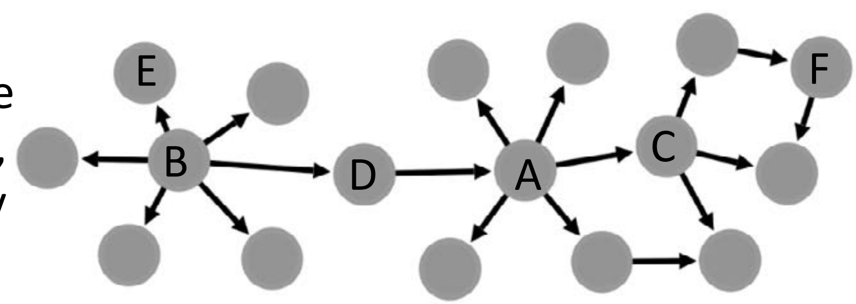
- **In- (out-) degree** – no. of counterparties a firm is selling (buying) to (from)
- **In- (out-) strength** – size of a counterparty's net selling (buying) position
- **Multilateral position** – in-strength minus out-strength



A -> in-strength = 10
-> out-strength = 6 (4 + 2)
-> multilateral seller = 4 (10 - 6)

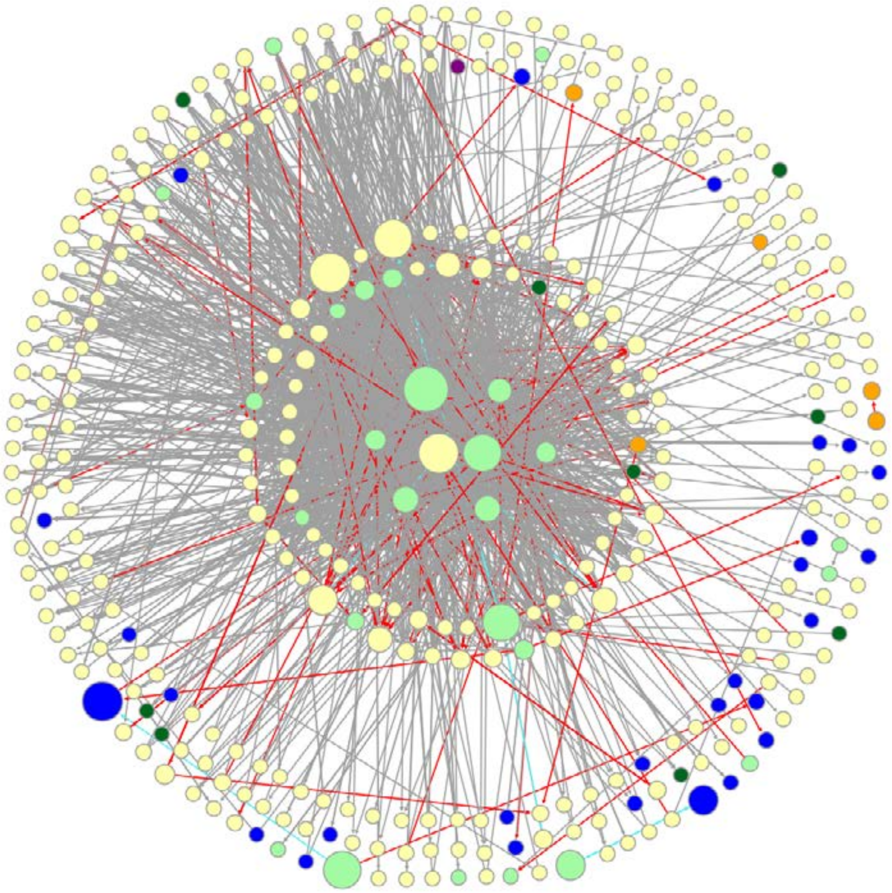


- **Density** – ratio of actual links to possible links
- **Betweenness centrality** – how often a node appears on shortest paths between nodes in the network (i.e. identifies hubs/major dealers)
- **Eigenvector centrality** – the direct and indirect connections of a node (i.e. a node may have only one edge to another node, but will have a high eigenvector centrality score if that node is highly connected)

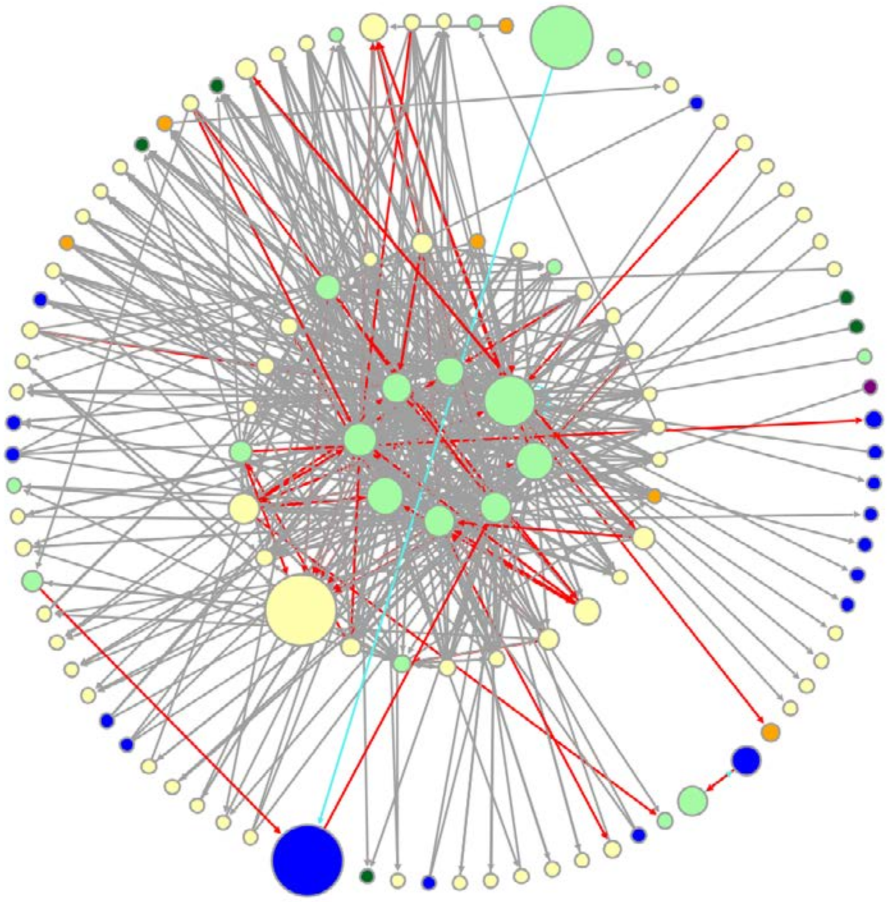


Irish CDS Network

Gross Notional



Net Notional*



Source: EMIR data from 1 September 2015 and authors' calculations.

NB: Size of node is proportional to total exposure, core nodes have more links

*Kolmogorov-Smirnov test failed to reject null that the degree distribution follows a power law distribution at 1% significance level

Network Topology

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	Gross	Net	Net, Sub-Sample of Irish SPVs
Nodes	373	117	30
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Unique CDS trades	15,103	4,598	360
Reference Entities	897	846	328
Density (%)	1.4	4.6*	4.1
Mean In- or Out-degree (no. of links)	5.0	5.3	1.2**
Mean In- or Out-strength (size of link, €m)	238.2	341.9	401.6**

Source: EMIR data from 1 September 2015 and authors' calculations.

*Peltonen et al. (2014) find a density 0.5% for the global net CDS market
**Non-financial corporations have a mean in- or out-degree of 1.9 and a mean in- or out-strength of €40.5 million

Top-10 Counterparties

Rank	In-degree		Out-degree		In-strength (€m)		Out-strength (€m)		Multilateral selling position (€m)		Between-ness	Eigen-vector centrality
1	MFI 5*	38	MFI 6*	37	OFI 22	8,548.2	OFI 16	7,349.6	OFI 22	8,390.1	MFI 5*	MFI 5*
2	MFI 12*	38	MFI 5*	35	SPV 19	8,268.3	MFI 5*	3,466.0	SPV 19	7,808.9	MFI 10*	MFI 12*
3	MFI 6*	36	MFI 41*	31	MFI 5*	2,222.4	MFI 9*	2,564.1	OFI 18	1,924.1	MFI 6*	MFI 41*
4	MFI 10*	34	MFI 12*	29	SPV 63	2,049.3	MFI 41*	2,492.5	SPV 63	1,804.2	MFI 12*	MFI 6*
5	MFI 41*	32	MFI 10*	28	OFI 18	1,944.8	MFI 13	2,049.3	MFI 30*	565.2	MFI 41*	MFI 9*
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7	MFI 9*	30	MFI 8*	28	MFI 7*	1,172.6	MFI 12*	1,574.0	SPV 59	506.6	MFI 8*	MFI 3*
8	MFI 8*	27	MFI 3*	27	MFI 41*	1,097.6	MFI 8*	1,554.4	OFI 20	336.4	MFI 9*	MFI 8*
9	MFI 3*	26	OFI 1	18	MFI 10*	1,087.8	MFI 6*	1,494.1	OFI 46	239.0	OFI 22	OFI 22
10	OFI 22	14	OFI 4	13	MFI 6*	966.2	MFI 10*	1,484.4	OFI 23	89.0	MFI 3*	MFI 10*

* Indicates a globally systemically important bank (G-SIB) and a G-16 dealer (i.e. the 16 major derivatives dealers)

Multilateral Positions

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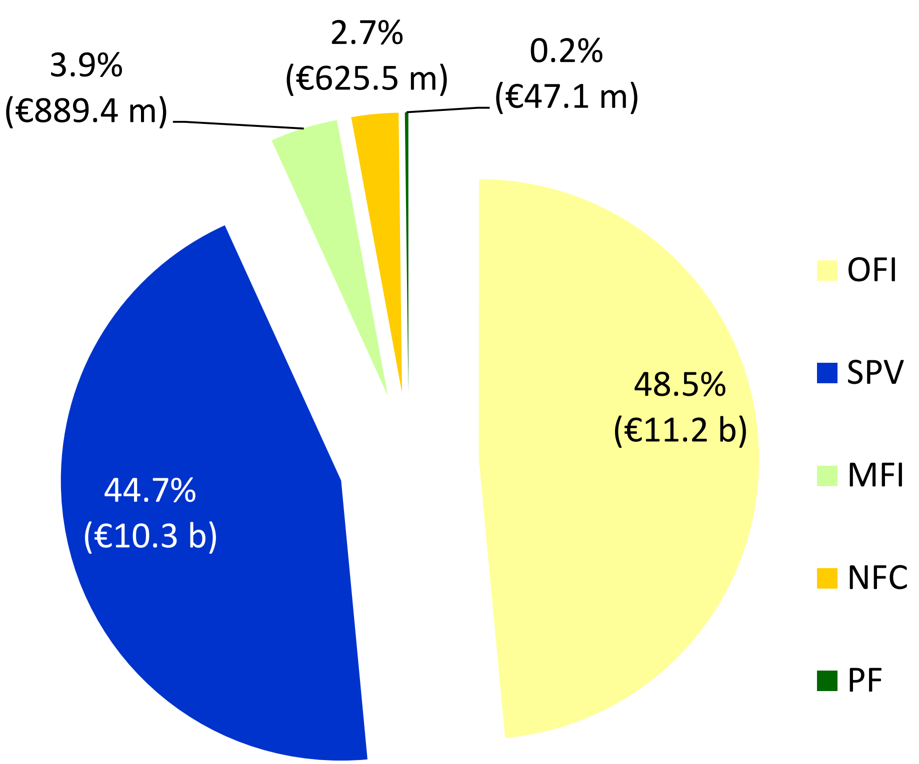
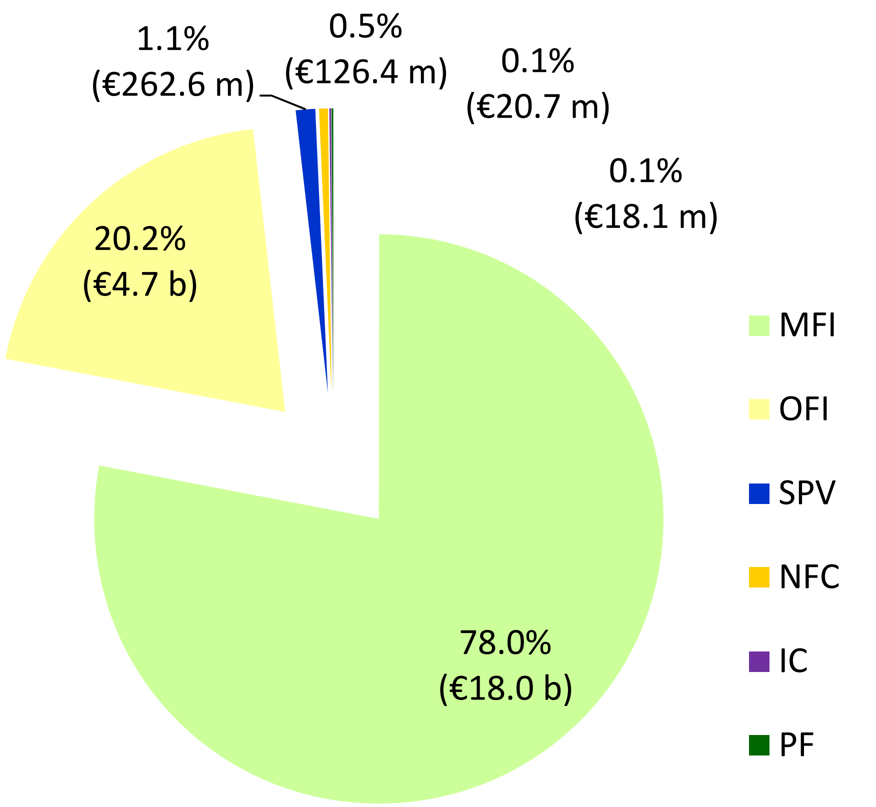
Sellers



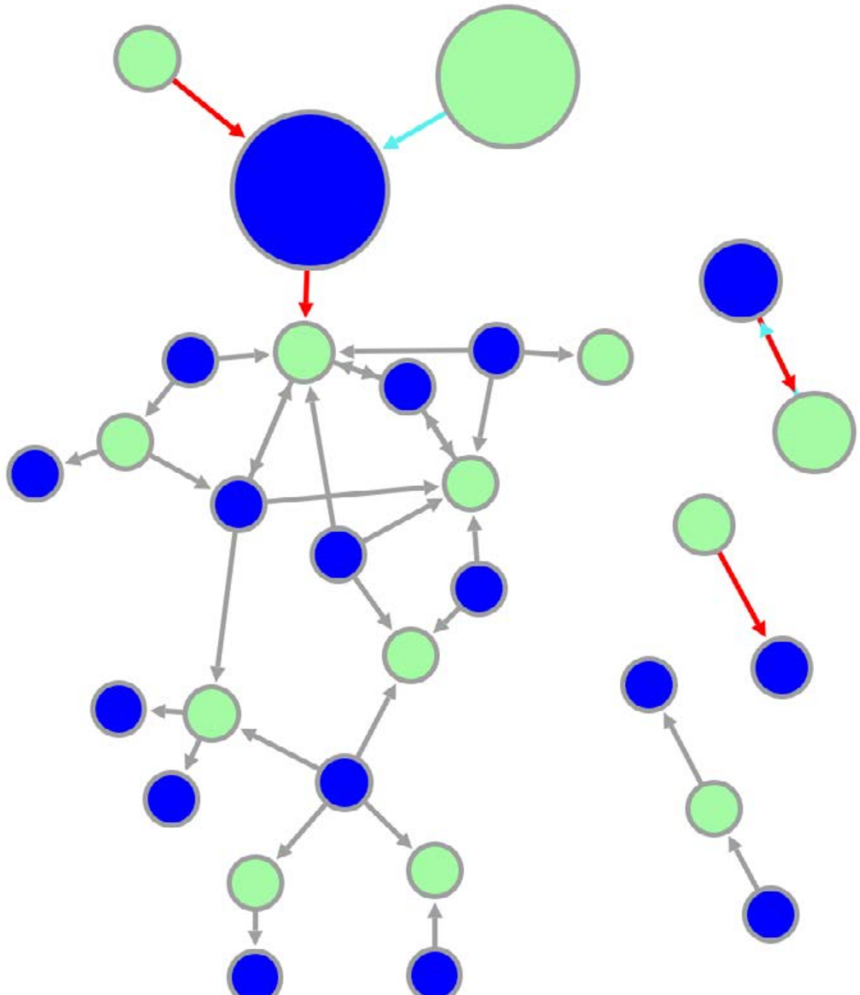
Buyers



Source: EMIR data from 1 September 2015 and authors' calculations.

NB: Net multilateral = net total position over all links

SPV Sub - Sample



Source: EMIR data from 1 September 2015 and authors' calculations.

Conclusion

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- EMIR data quality issues
- Representative sample
- Irish CDS market is highly concentrated
  - Core of non-domestic MFIs and OFIs
  - Large periphery of firms with only a few links
- SPVs are large net sellers of CDS to non-domestic MFIs