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Citation

Priem, R., & Rogge, E. (2024). Do single-name CDS markets lead equity and bond markets?: a literature review. *S&p Global Market Intelligence Research Paper Series*. doi:10.2139/ssrn.4935359

Version: Publisher's Version

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Downloaded from: https://hdl.handle.net/1887/4209568

Note: To cite this publication please use the final published version (if applicable).

Do single-name CDS markets lead equity and bond markets?
A literature review

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(July, 2024)

Abstract

This paper provides a literature review on studies examining whether the single-name CSD market leads the equity and bond markets. In the wake of the banking turmoil in 2023, regulators and media are concerned that an opaque and illiquid derivative market can be used to impact the stock and/or bond prices of reference entities, in particular for global systemically important financial institutions. Previous studies support the view that CDS spreads lead bond prices. Yet, with respect to the lead-lag relationship with equity prices, findings are inconclusive. This paper highlights that contradictory results cannot be explained by the choice of the geographical region, the time period, the methodology or the data source. Future areas for research are put forward in this article in an attempt to bring more clarity on the CDS-equity relationship.

Keywords credit default swaps, financial regulation, financial stability, derivatives, central clearing, investor protection
JEL Codes G15 G18 G21

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No funding has been received for this article. There are no conflicts of interest.

1. INTRODUCTION

Single-name credit default swaps (CDS) are financial derivative contracts between two counterparties to 'swap' or transfer the risk of default of a borrowing reference entity (i.e. a corporation, bank, or sovereign entity). The buyer of the CDS, also called the 'protection buyer', needs to make a series of payments to the protection seller until the maturity date of the financial instrument, while the seller of the CDS is contractually held to pay the buyer a compensation in the event of e.g. a debt default of the reference entity. Single-name CDSs are mostly traded in the over-the-counter derivatives markets, typically on confidential, decentralized systems, having a total global value of around 4 trillion USD in 2023 according to Reuters[1]. The terms of the contract are negotiated between the two counterparties, thereby making these contracts tailored to their preferences. Although 51.2% of single-name CDSs traded notional is centrally cleared[2], a disadvantage, however, of over-the-counter derivative markets is that they are more opaque with very limited access to pre-trade and post-trade information compared to listed financial instruments (see e.g. Daures-Lescourret and Fulop 2022). Moreover, the positions, identities of end-users, pricing, and other transaction details of privately negotiated contracts are not readily available within the marketplace. According to the International Capital Markets Association (ICMA), corporate single-name CDSs represent around 60% of the total CDS notional outstanding, of which 20% refers to financial reference entities; while the remainder is for sovereign CDSs.[3]

In 2023, there was upheaval around strong movements in the CDS spread for Deutsche Bank, coinciding with a sharp decline in its share price. It prompted various official statements from policymakers, including German Chancellor Olaf Scholz, in support of Deutsche Bank[4]. Rightly or wrongly, there is a fear that movements in the CDS market may bring down a global systemically important bank. To understand the CDS-equity/bond dynamics better, this paper provides an extensive literature review on whether single-name CDS markets lead equity and bond prices. Under the caveat that previous studies are based on historical data, which does not

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[1] See e.g. Reuters, Explainer: What are credit default swaps and why are they causing trouble for Europe's banks? <https://www.reuters.com/markets/what-are-credit-default-swaps-why-are-they-causing-trouble-europes-banks-2023-03-28/>

[2] < https://www.isda.org/a/0jLgE/Single-name-CDS-Market-Update.pdf>

[3] As per the ICMA report on the European Single-Name CDS market <https://www.icmagroup.org/assets/documents/Regulatory/Secondary-markets/The-European-Corporate-ingle-Name-Credit-Default-Swap-Market-SMPC-Report-150218.pdf>

[4] See e.g. Reuters reporting on Deutsche Bank < https://www.reuters.com/business/finance/deutsche-bank-ubs-hit-bank-fears-spark-stress-signals-2023-03-24/>

warrant to see similar future market evolutions, it is of key interest to finance professionals to understand how new information could be incorporated into securities prices and how price discovery (i.e. the process in which trading incorporates new information and market participants reflect their expectations into asset prices) could function across markets.[5] If new information is simultaneously priced into different security markets, it shows that these are all equally efficient, while evidence of one market pricing information faster than another suggests market inefficiencies (see e.g. Howell 2016). Price inefficiencies can be caused by liquidity differences in the various markets or because traders in one market have an informational advantage (see e.g. Marsh and Wagner 2016).

A literature review can provide a comprehensive understanding of the role and the impact of the single-name CDS market, thereby identifying gaps in current knowledge and suggesting directions for future research. This article goes beyond previous studies such as Culp et al. (2016), who provide a review of the empirical academic literature on single-name credit default swaps. Indeed, where Culp et al. (2016) provide a broad overview on the market, this article focuses in much more detail on the lead-lag relationship between CDS prices and the prices of equity and debt instruments. Additionally, this article contains novel academic studies being published after 2016, which might provide new insights given that financial market conditions have changed over the last few years and have witnessed stressed-market circumstances.

Based on an extensive literature overview, this paper highlights that previous literature cannot serve as firm evidence that CDS prices steer equity prices. Previous studies supports the

[5] In this article, we do not examine empirically whether the regulators' claim that CDS market participants significantly steered equity or bond prices holds, given that the sample is too small for this specific event and non-anonymous trading data is also not available. When simply looking at the evolution of the equity and bond prices of Deutsche Bank, it appears that since 7 March 2023, the share price of the bank already tended to decline around the same time that the five-year CDS price started to increase. A probable cause is that traders, already nervous due to market events, used CDS spreads as a proxy to determine the increased risk of default of Deutsche bank. They could have thus taken an increase in CDS spreads as an indicator of an increase in the probability of default. For Deutsche Bank, CDS prices thus did not start to increase already before the drop in equity prices nor can one detect that equity prices started to drop just after or before the increase in CDS prices. Also for bond prices, one can observe that e.g. the Deutsche Bank 7.5% bond dropped considerably on 7 March 2023, so the same time that the five-year CDS price started. A similar picture can be observed for UBS where the five-year CDS prices started to increase from 6 March where share prices also started to drop from 8 March, although not as largely as for Deutsche Bank. Also, both for Deutsche Bank and UBS, one can detect that from April 2023 until July 2023, the equity prices remained rather stable, while CDS prices decreased. Regarding bonds, the e.g. UBS Bond 5.125% dropped considerably on 7 March 2023. Simply observing these evolutions cannot lead to general conclusions given that these are concrete events, there is no access to intraday and/or microstructure data, and compounding factors are not controlled for.

view that CDS spreads lead bond prices but with respect to the lead-lag relationship with equity prices, findings are inconclusive. Future areas for research are put forward in an attempt to get further clarity on the CDS-equity relationship. The remainder of this paper is organized as follows: Section 2 provides a short account of the 2023 turmoil in the European banking sector and the link with the CDS markets. Section 3 gives a detailed overview of the single-name CDS market, including their mechanics, modelling approaches, linkage with equity and bond prices, and usage. Section 4 provides an extensive literature overview, while Section 5 concludes and provides future areas for research.

2. THE 2023 TURMOIL IN THE EUROPEAN BANKING SECTOR

In March 2023, three small-to-mid-size US banks (i.e. Silicon Valley Bank, Silvergate Bank, and Signature Bank) ran into financial difficulties with spillovers to Europe where Credit Suisse needed to be taken over by UBS. Holders of the 17 billion USD risky Credit Suisse bonds were not part of the rescue deal and investors were left empty-handed, which contributed to the rise in fear of having similar negative consequences at other European Banks.[6] The Europe Stoxx Banks index, which encompasses Europe's biggest lenders, fell by more than a sixth.[7] During that turmoil, EU banks' CDSs rose considerably. For instance, Deutsche Bank's CDS price rose from 55 basis points on 8 March to 250 basis points on 24 March, while UBS's CDS price also faced records at 200 basis points, mainly because investors started to fear the stability of the broader European banking system.[8] For Deutsche Bank, there were more than 270 CDS transactions with a total notional of US 1.1 billion in the week following UBS's takeover of Credit Suisse. This represented a more than four-fold increase in trade count and a doubling in notional value compared with average volumes of the first 10 weeks of the year. The CDS market is typically illiquid with only a few transactions a day for a particular reference entity, so this increase in trading volumes was exceptional.

On 28 March 2023, the press reported that regulators had identified a single CDS transaction referencing Deutsche Bank's debt of roughly 5 million EUR conducted on 23 March; this transaction was suspected to have fuelled the dramatic sell-off of in equity on 24 March

[6] Forbes reporting on Deutsche Bank <https://www.forbes.com/sites/dereksaul/2023/03/24/whats-happening-with-deutsche-bank-as-shares-slide-9/>

[7] Investing.com reporting on Deutsche Bank <https://www.investing.com/news/stock-market-news/deutsche-bank-shares-plunge-after-spike-in-credit-efault-swaps-3038811>

[8] The Street reporting on Deutsche Bank <https://www.thestreet.com/investing/stocks/deutsche-bank-tumbles-default-protection-spikes-as-crisis-spreads>

causing Deutsche Bank's share price to drop by more than 14 percent.[9] Hence, an illiquid market with relatively small deals could have exerted a heavy impact on share prices. The Financial Times subsequently reported that the recent Deutsche Bank drama could imply CDSs are a bad barometer of whether a bank is in trouble. It was concluded they could serve as an instrument of mass deception because Deutsche Bank had only a limited number of features in common with struggling Credit Suisse, which Swiss officials made absorbed with UBS a few days before.[10] A disadvantage of such an illiquid derivative market is thus that CDS market participants can steer the CDS market by actively trading, thereby resulting in signals that can impact the financial decisions of counterparties and/or commercial or trade creditors toward the reference entity in turn impacting its stock price.

One of the conclusions drawn by regulators, such as ESMA[11], regarding the 24 March event was that single-name CDS contracts are opaque, and in consequence, subject to a high degree of uncertainty and speculation as to the actual trading activity and its drivers. Moreover, there are concerns that single-name CDSs provide market participants with mechanisms to manipulate CDS prices to generate profits in related financial instruments (e.g. their reference entity's stocks or bonds): after all, the single-name CDS market is opaque without a lot of transparency making cross-market manipulations harder for other market participants to detect and prevent. This view is not new as former chairman of the Securities and Exchange Commission (SEC) Erik Sirri already stated before the House Committee on Agriculture in 2008 that the CDS market can impact the debt and cash equity securities markets as the latter are directly affected by CDSs due to the interrelationship between the markets.[12]

3. AN OVERVIEW OF THE SINGLE-NAME CDS MARKET

3.1. The single-name CDS contract

Single-name CDSs, developed in the '90s by JP Morgan, are financial derivative contracts between two counterparties to 'swap' or transfer the risk of default of a borrowing reference

[9] See e.g. RISK.net <https://www.risk.net/regulation/7957063/eus-late-cds-transparency-push-triggers-trader-fears?check_logged_in=1>

[10] The Financial Times reporting on Deutsche Bank <https://www.ft.com/content/c233fd81-c80a-4a26-be7c-8d1c9665ac86>

[11] ESMA letter to the European Commission <https://www.esma.europa.eu/sites/default/files/2023-06/ESMA74-1658524332-687_Letter_to_Commission_on_MiFIR_transparency_CDS.pdf>

[12] SEC testimony <https://www.sec.gov/news/testimony/2008/ts112008ers.htm>

entity (i.e. a corporation, bank, or sovereign entity).[13] The buyer of the CDS, also called the 'protection buyer', needs to make a series of payments to the protection seller until the maturity date of the financial instrument, while the seller of the CDS is contractually held to pay the buyer a compensation in the event of a debt default of the reference entity or another credit event. The seller of the CDS thus insures the buyer against the reference entity defaulting. The buyer of the CDS needs to make a series of payments (i.e. the CDS spread, also called the CDS price, fee, premium, rate, or coupon; which is the number of basis points per annum that the seller of the derivative charges the buyer, applied to an agreed notional amount, for providing protection) to the seller during the time to maturity of the financial instrument. The buyer agreeing to make regular payments is also known as the premium leg of the contract, while the contingent payment of the seller in case of default is known as the protection leg. The payment due on default of the reference entity, or the loss payment, represents the nominal amount minus the recovery value of the reference entity i.e. the loss-given-default. Selling protection through a CDS contract is similar to a leveraged long position in bonds of the underlying reference entity, exposing the protection seller to similar risks as those of a creditor. For the entities buying protection through a CDS contract, it is as having a leveraged short position in bonds of the underlying reference entity, allowing protection buyers to either hedge default risk they may already be exposed to or effectively take a short position in the default risk of the underlying reference entity. In general terms, the CDS market is a zero-sum game, where losses by one party to a transaction are offset by gains by the other party.

Most contracts are based upon the standards documentation developed by the International Swaps and Derivatives Association (ISDA). It will include the CDS spread, usually defined in terms of a notional amount being protected, which indicates the cost per year to buy or sell exposure to the possibility of a default event. It is thus a market price of the default risk of a reference entity in addition to its corporate bond yield from the cash market. The contract will further include a (set of) reference bond(s), issued by the reference entity on which default protection is sought. The actual determination of a default event is performed by the

[13] Besides single-name CDS, CDS indices exist, which are derivative contracts that are made up of a collection of credit default swaps on reference entities. For instance, the CDX family of indices has North American and Emerging Markets reference entities as constituencies, while the iTraxx family is based more on European and Asian reference entities. CDS indices are more liquid than single-name CDSs. Index CDSs are out of scope of this article.

ISDA Determinations Committee. This process typically involves an auction determining the actual loss amount that will need to be paid.

3.2. Theoretical background: modelling single-name CDSs

Before providing a detailed empirical literature overview of the lead-lag relationships between CDS spreads, equity prices and bond prices, this section provides an overview of the modelling approaches as a theoretical background giving insights into the different types of joint movements of CDS rates, equity prices and bond prices. In general, the CDS spread depends on the expected loss associated with the default of the underlying entity, determined by the probability that the reference entity effectively experiences a credit event over the life of the CDS contract, and the loss-given-default (see e.g. Pan and Singelton 2008, Fathi and Nadar 2006, Gehde-Trapp et al. 2015). The modelling approach for single-name CDSs thus has relatively straightforward building blocks. There are broadly two categories of modelling approaches: the 'structural' and the 'reduced form' approach.

The structural models are the first major approach (e.g. Black and Scholes 1973, Merton 1974, or Fathi and Nadar 2006). These models attempt to capture the value of a firm's assets, where the default event is determined at the point where the value drops below a certain threshold. In particular, Merton (1974) describes the equity of a firm as a call option on the underlying value of the firm with a strike equal to the firm's debt. Initial research was not necessarily positive as regards the prediction of default with this approach (Jones 1985). However, there have been many further improvements of Merton's model since. Most notable is the approach by Kealhofer (2003) and Vasicek (1984), leading to the commercial KMV approach, which was later taken over by Moody's creating the Moody's KMV approach (e.g. Crosbie and Bohn 2003). These are more advanced versions of the structural model which use, amongst others, the market value and volatility of equity to estimate the default probability and the 'distance to default'. All structural models, which seek to predict the default event, or estimate the default probability, remain based on equity and equity volatility of the reference entity. This assumption is supported by various research papers, showing that reference entities' determinants such as the volatility of their equity prices (see e.g. Zhang et al., 2009, Cao et al., 2010) and the amount of leverage they take, determine the risk premium reflected in the spreads (see e.g. Tang and Yan 2017). At the very least, the structural approach provides a historical and theoretical background as to what kind of relationship might exist between equity prices and

CDS rates. In other words, it provides a clear theoretical justification and linkage between movement amongst these different asset classes. Nonetheless, Annaert et al. (2010) show that the explanatory value for CDS spread movements for European banks remains limited, amongst others due to other factors such as liquidity and market wide economic factors impacting the CDS spread.

In the reduced form approach, in its simplest form, the arrival of a default event is captured by a Poisson process, with the hazard rate or default intensity calibrated to the observed market prices in the relevant CDS at different maturities (e.g. Jarrow and Turnbull 1995, Duffie 1999, Hull and White 2000, Pan and Singelton 2008, Gündüz and Uhrig-Homburg 2011, Gündüz and Uhrig-Homburg 2014, or generally Schönbucher 2003); for calibration O'Kane and Turnbull 2003). The recovery rate can be chosen, for example, based on historical data for industry sectors or the seniority of the reference debt. This model could additionally be calibrated to bonds issued by the reference entity. In this approach, the difference between CDS spreads and bond prices is that bond prices are driven by additional factors other than the default probability of the issuer, such as issuing size, time since issuance, and the size of a transaction. As a consequence, calibrating only to CDS spreads may provide a more accurate picture of what the market estimates as the default probability. As the reduced form approach produces an arbitrage free default probability derived from observed CDS prices, it can be used for valuing and risk trading book positions. Nevertheless, as CDS spreads reflect expected credit losses, a significant amount of research detected that changes in spreads contain information that can be used to estimate the probability of future adverse credit events at the underlying reference entities (see e.g. Hull et al., 2004, Finnerty et al., 2013, Avino et al. 2019). The reduced form approach can be extended and made more sophisticated. One could, for example, extend the two-status universe (default or not), towards a full rating transition approach. In that case, a Markov chain could be used to describe the transition between different credit ratings (e.g. Jarrow, Lando and Turnbull 1997). The default event is then modelled as an absorbing state. This approach introduces a dynamic element to the spreads as these will jump on transition to a different rating. There is empirical research available in this area, for example on the impact on CDS spreads of corporate news prior to a negative rating change announcements (e.g Norden 2017). In practice, however, this model is more difficult to calibrate to market prices due to the number of variables and it is more useful as a predictive tool as opposed to valuing and risk managing a trading book. Another extension of the basic Poisson model would be to make the hazard rate stochastic, for example by allowing it to follow a term structure model (e.g. Lando 1998, Duffie and Singleton 1999). In this approach, one could also allow for correlation between the discount rate process and the hazard rate process. The reduced form approach is, in its simplest form, thus relatively straightforward and based on the CDS spread – which it calibrates to and will reproduce by way of construction.

The two modelling approaches also provide insights into the different types of joint movements of CDS rates, bond prices, and equity prices. The reduced form models suggest that there is a difference between modelling 'usual' movements of spreads and rates, captured by Brownian motions, and 'default' movements or jumps, captured by jump processes. The latter is exemplified in Schönbucher (2000), describing both interest rates and credit spreads as lognormal diffusion processes. The credit spread thus do not only reflect announcement effects regarding credit events concerning the financial conditions of the reference entities but also anticipation effects. CDSs are subject to considerable jump-to-default risk, as the onset of a credit event for the underlying reference firm could create an abrupt or non-linear change in the CDS prices (see e.g. Dutt 2009, Baker 2016).

The above is not the whole story for the modelling of CDSs. For example, the credit spread encompasses the probability that the protection seller itself would default (see e.g. Loon and Zhong 2014). Indeed, the buyer faces the risk that the seller of the derivative defaults and thus still loses protection against the default of the reference entity. Likewise, the seller takes the risk that the buyer defaults on the contract, depriving the seller of the expected revenue stream. The CDS spread thus does not only represent the credit risk in a particular reference firm, where the credit spread increases if the risk of default of the firm increases but the joint probability that the protection seller and the underlying reference entity default together. In the reduced form approach, such dependence could be added by allowing the hazard rate of one entity to jump sharply in case of the default event of another entity (e.g. Davis and Lo 2001, Kijima 2000, Schönbucher and Schubert 2001 and Rogge and Schönbucher 2003).

There are other drivers of CDS spreads, in particular in the structural approach, which could be considered. CDS spreads may contain a non-negligible liquidity premium considering the market-wide liquidity risk for CDSs but also depend on how liquid the market for the bonds of the underlying reference entity is (see e.g. Junge and Trolle 2015). The national and global macroeconomic conditions will significantly impact CDS spreads as well (see e.g. Baum and Wan 2010, Tang and Hong 2017). According to Culp et al. (2016), this is because the sellers of protection want to be compensated for the risk that they are unable to hedge or offset their CDS sales quickly or without adverse price impact. Finally, single-name CDS spreads are driven by investor sentiment and general risk aversion. That is, an increase in market-wide risk aversion positively influences CDS spreads (see e.g. Berndt and Obrej 2010, Aizenman et al., 2013, Doshi et al., 2017). To mitigate all aforementioned latter risks, most of the CDSs involve a collateral agreement where a margin is posted at the inception of the contract with a central counterparty (i.e. in case of central clearing) or a custodian bank (i.e. in case of bilateral clearing). Subsequent collateral calls can be asked based on the changes in the value of the CDS contract, which further can reduce counterparty exposure.

3.3. How Single-Name CDSs are used

CDSs are used by a range of market participants, including corporate bond market-makers, investors, hedge funds, loan book traders, and participants managing banks' counterparty credit risk exposures. Yet, mostly investment firms and banks dominate - thereby leading to a very concentrated CDS market (i.e. 61% of the positions) - in their capacity as dealers regularly posting indicative buy and sell quotes on major data providers and interdealer brokerage systems, followed by the negotiation of the terms of the contract (see e.g. Fletcher 2019). The single-name CDS market is thus basically a decentralized dealer market where trading happens via bilateral non-anonymous communication such as instant messages, email, and telephone. The CDS trading network is two-tiered and consists of an inner core of major dealers, the so-called G14 dealers, who are the largest derivatives dealers worldwide and hold around 90% of the CDS notional amounts, according to IOSCO.[14] Examples of these dealers are credit institutions like Bank of America, Barclays, BNP Paribas, Citigroup, Deutsche Bank, Goldman Sachs, HSBC, JP Morgan Chase, Morgan Stanley, Société Générale, UBS, and Wells Fargo.

According to the International Capital Markets Association (ICMA), there are currently about five fully committed market markers for corporate single-name CDSs in Europe and only around three active within each sector, being too low to support a deep and liquid market.[15] Indeed, the Top 1000 corporate entities have around 2 trades per day across all maturities and

[14] IOSCO on the CDS market <https://www.iosco.org/research/pdf/publications/Credit%20Default%20Swap%20Market.pdf>

[15] ICMA report on the European Single-Name CDS market <https://www.icmagroup.org/assets/documents/Regulatory/Secondary-markets/The-European-Corporate-Single-Name-Credit-Default-Swap-Market-SMPC-Report-150218.pdf>

seniority with an average daily notional trade of USD 13 million in the first quarter of 2023. For European entities, there are only five trades per day on average with a notional of 35 million EUR. Specifically for European banks, there are around 10 trades per day for most active CDSs with a daily notional of 75 to 125 million EUR. These dealers act mostly on behalf of (buy-side) investors in bonds issued by companies, banks, or governments, who are considered non-dealers. Put differently, dealers act mostly as market makers and are willing to take the opposite side of a CDS trade with another dealer or non-dealer. Non-dealers typically use CDSs to hedge their credit exposure or to gain exposure to credit risk via the usage of a dealer. They include mostly smaller banks and other financial institutions like pension funds, mutual funds, or other institutional investors. Yet, dealers often execute transactions between themselves to hedge trades executed with clients or for other risk management purposes. According to Getmansky et al. (2018), this high level of interconnectedness makes sure that in case of CDS losses at one institution, cascading losses throughout the financial market as a domino effect could be triggered, thereby leading to widespread failures of financial institutions, a loss of investor confidence, and a generalized crisis. Compared to the equity and bond markets, retail investors are generally absent in the CDS market.

Market participants generally act within one of three roles: hedgers, speculators, and arbitrageurs. First, buyers of CDSs can be entities that want to hedge the risk of default on a bond or other debt instrument they have in their portfolio. Investors owning the bonds of the reference entity can replicate the economic payoff of a CDS contract by shortening the bonds and reinvesting the proceeds at the riskless rate, but CDS might be more attractive compared to short selling because of their ability to reduce the risk associated with rolling over short positions. In addition, the market liquidity for the bond they want to sell could be minor at certain times, giving hedgers incentives to reduce their exposure with CDSs. This way, they can neutralize their credit exposure until liquidity improves in the bond market and they can exit their bond positions at a more favourable term. Buying a CDS could also be useful to lenders where a reference company is overly concentrated in their portfolio. For sellers of the CDS, the credit exposure is similar to taking a long position in the bond.

Second, market participants could be speculators who do not hold an interest in or bear any risk of loss relating to the underlying bond or debt instrument, also called uncovered or naked credit default swaps. In this case, the goal is to speculate on the creditworthiness of the reference entity and thus to “gamble” on its likelihood of default. Investors having a positive view of a reference entity's credit quality can sell protection and collect the payments that go along with it rather than invest directly in the company's bonds. Investors with a negative view can buy protection for a relatively small periodic fee and receive a big payoff if the reference entity defaults on its bonds or faces another credit event. In this respect, CDSs are different from insurance contracts as the latter provide indemnities against the losses suffered by the policyholder on an asset in which an insurable interest is held. A CDS in contrast can provide a pay-out to a holder that does not own the underlying security of a reference entity. Another difference with insurance contracts is that the protection buyer or seller could transfer the CDS contract to another party, while an insurance contract is a personal contract and non-transferable.

Besides hedgers and speculators, CDSs are used by arbitrageurs who attempt to exploit price discrepancies between different products. For instance, they can rely on the fact that a company's stock price and its CDS spread exhibit a negative correlation. Indeed, if a firm's outlook is negative, both its stock price decreases while the CDS spread should tighten given the increased risk of default on its debt. Arbitrageurs attempt to exploit this spread between a reference entity's CDS and equity prices in certain situations. Alternatively, they could take opposite positions in bonds and CDSs thereby monetizing on any temporary price anomalies between the two. Another trading strategy often observed is exploiting a possible CDS index skew. This is the case when the CDS index deviates from its intrinsic value implied by the market levels of the constituent single-name CDSs, which is often the case (O'Kane (2011)). Depending on the size and direction of the skew, arbitrageurs will either buy or sell the index CDS and then sell or buy each of the underlying single-name CDSs subsequently unwinding the trade once the index price normalizes. An arbitrageur could also buy a CDS contract in one market and simultaneously sell the same CDS in another market to exploit a difference in the price for the CDS contracts in different markets due to pricing inefficiencies. Just as speculators, arbitrageurs do not necessarily have an exposure to the reference entity but trade CDSs thereby bringing liquidity to the market.

G20 legislators decided in September 2009 at the Pittsburgh Summit to reform the CDS market by requesting improvements in transparency and regulatory oversight via a move towards trading on exchanges or electronic trading platforms, central clearing, and trade reporting to repositories. This regulatory reform was preferred over an outright ban on these financial products altogether, as CDSs, in general, can also have positive benefits for reference entities.[16] Several empirical studies found that the introduction of single-name CDSs negatively impacts reference entities' borrowing costs (see e.g. Ashcraft and Sants 2009, Ismailescu and Phillips 2015, Salomao 2017). The reason for lower borrowing costs is that the initiation of CDS trading can have a screening benefit as the effect of CDS initiation depends on the borrower's credit quality. Yet, this seems mostly the case for reference entities that are informationally transparent and have a relatively low risk while not for opaque and high-risk corporates and sovereigns. According to Norden et al. (2014), as banks can use single-name CDSs for hedging purposes, they realize benefits and cost savings which they pass along to the borrowers in the form of lower funding costs. In addition, Shan et al. (2014) found evidence that loan covenants are loosened after the initiation of CDS trading for new loans, mostly for high-quality and transparent firms. Not only can reference entities borrow at a lower cost, but they achieve higher leverage ratios and longer debt maturities (see e.g. Danis and Gamba 2018).

According to Bolton and Oehmke (2011), credit protection held by existing creditors may make some of them more willing to issue new debt to finance positive net present value investments. Moreover, Saretto and Tookes (2013) found that CDS availability not only leads to greater increases in credit and debt maturities but also that this happens in periods in which credit supply is constrained or when unexpected shocks to local credit supplies occur. One potential explanation for this finding, apart from the fact that the sellers could hedge their exposure, is that credit spreads capture market participants' expectations about the expected credit risk, recovery rate, and loss-given default (LGD) of these underlying firms. As a consequence of CDSs leading to less adverse selection, lenders are willing to provide credit at a lower cost.

Opponents of a ban of CDSs will also indicate that naked CDS transactions create liquidity and price accuracy in the CDS market, which benefits also the non-naked CDS traders (see e.g. Dutt, 2009). That is, the fewer traders and thus transactions a market contains in general, the less liquid the instruments will be and the more likely the prices of these instruments will

[16] While the US Congress rejected the proposal to ban naked CDSs, such a ban is the case for naked CDS on sovereign bonds in the European Union, which was installed in 2011 and became in effect as of 1 November 2012. Naked CDS transactions namely increase the level of speculation on the default of sovereign entities and there is an issue with the protection buyer's incentives under the contract. If a protection buyer does not own the underlying reference asset, it has incentives to rather destroy value at the reference entity, like pushing for a default. The European regulators were thus concerned that CDS contracts would contribute to a decline in sovereign bond prices and increase the probability of settlement failure. They also contended that the interaction between the sovereign bond and CDS market could result in mispricing on the bond market and lead to higher funding costs for governments.

not accurately reflect the true price of the risk. Single-name CDSs have benefits for borrowers to reference entities as well as they facilitate credit risk transfer. That is to say, instead of being forced to sell a risky loan or rebalance a whole portfolio, single-name CDSs can be a tailored credit risk transfer solution and thus a precise risk management tool to be protected against the default risk of the reference entity. Furthermore, during the tenor of the CDS, hedgers do not need to be concerned about interim changes in market expectations on the probability of default and/or the expected recovery rates on the underlying reference entity. Another advantage of single-name CDSs is that they play an important role in information aggregation: the CDS spreads can reveal market participants' expectations of the probability that the underlying reference entity will experience a credit event or that the market-implied recovery rate and loss-given default will change (see e.g. Culp et al., 2016).

4. LITERATURE REVIEW

In the case of efficient markets, both the equity/bond and CDS markets incorporate the probability of default immediately (see Fama 1970). Yet, when there exists e.g. a problem of asymmetric information between the diverse markets and thus one of them embeds new information first, a lead/lag relationship could exist, mainly because of differences in the number of traders, liquidity, and maturity of the particular market. Based on previous literature, this section thus examines whether a lead/lag relationship exists between CDS spreads and equity prices on the one hand and between CDS spreads and bond prices on the other hand.

4.1. Do CDS spreads lead equity prices?

Concerning whether CDS spreads drive equity prices, previous research has not found conclusive evidence, as shown in Table 1.

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Insert Table 1 about here

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Focusing first on the papers that indicate that CDS spreads lead equity prices, Lake and Apergis (2005) made use of 1,612 daily observations from the US, German, UK, and Greek markets, and found that CDS spreads led equity prices in the period 2004 to 2008. They showed that information contents coming from the firm's environment seemed to impact the CDS market first and then the stock market in a second phase. Archarya and Johnson (2007) used data on quoted CDS levels and bid-ask equity spreads for a cross-section of US firms over the period January 2001 through October 2004. They documented that significant incremental information was revealed in the CDS market in addition to the information already available in the equity market, suggesting that the single-name CDS market is the primary price discovery market. Yet, this finding seemed to hold mainly for corporate borrowers having negative credit news because they experienced negative credit developments. The intensity of the CDS-to-stocks information flow thus seemed to be stronger if a firm has experienced credit events and had more banking relationships. They explained this finding as insider trading in the CDS market by banks exploiting their private information obtained from lending relationships. Using a sample of daily quotes on CDS spreads for over 1,000 North American obligors from January 2001 to December 2004, Jorion and Zhang (2007) detected that Chapter 11 bankruptcies created contagion effects as there were CDS spread increases of industry competitors, while Chapter 7 bankruptcies were associated with significant competitive effects. Similar patterns were observed for equity prices, although more muted and less precisely estimated.

Chan et al. (2009) examined the dynamic relationship between sovereign CDS spreads and stock prices for seven Asian countries (i.e. China, Japan, Korea, Indonesia, Malaysia, the Philippines, and Thailand) for the period from January 2001 to February 2007. In terms of price discovery, they found evidence that CDS markets played a leading role in five out of seven countries (i.e. all except for Indonesia and The Philippines). The stock market dominated price discovery for only one country (i.e. Korea). Qiu and Yu (2012), focussing on five-year CDS contracts on senior unsecured obligations of 732 North American reference entities over the period 2001-2008, confirmed the previous findings of Acharya and Johnson (2007). Additionally, they documented that liquidity in the single-name CDS market was concentrated among large obligors and those near the investment-grade cut-off. More liquidity was associated with obligors for which there was a greater information flow from the CDS market to the stock market ahead of major credit events. This means that a CDS dealer having more information is also more likely to offer quotes to others, because better information allows them to set the quotes more accurately without running the risk of being 'picked off' by other informed traders.

Eyssell et al. (2013) studied sovereign CDS spreads in China from January 2001 to December 2010 and documented that China's sovereign CDS spread changes led stock returns. The results of US and EU studies thus seem to be generalizable to other countries like China. Rodriguez-Moreno and Pena (2013) used EU and US stock prices and CDS data from 2004 to 2009 and documented that systemic risk measures based on CDSs outperformed measures based on the stock market. They claimed that equity prices did not provide direct information on the probabilities of default compared to CDS prices. Xiang et al. (2013) examined credit risk price discovery between the US equity and CDS market for 174 firms between 2005-2009. They documented that the US CDS market took over price discovery leadership from the equity market during the great financial crisis. Amadori et al. (2014) explored the dynamics behind informed investors' trading decisions in European stock, options, and CDS markets using a sample of 163 European firms with daily observations from November 2003 to November 2010. They found that changes in CDS spreads could consistently forecast changes in stock prices and equity options' implied volatilities. Narayan (2015) focused on the equity and five-year CDS spread data relationship for 10 sectors of the S&P500 over the period 2 July 2004 – 30 March 2012 and found that CDS return shocks explained the forecast error variance of sectoral equity returns in the US: in the post-Lehman crisis period, CDS return shocks explained between 22% and 28% of the forecast error variance of equity returns on the financial, industrial, and material sectors. Kryzanowski et al. (2017) examined price discovery contributions of equity and CDS markets for US firms in 2009-2013. They found evidence that the two markets reacted differently to specific information events impacting either firms individually or the entire economy. In particular, negative earnings surprises led to large relative increases in price discovery in the CDS market, especially for firms where a high degree of uncertainty and opportunities for insider trading existed. Moreover, positive or negative economy-wide information events were generally associated with relative increases in price discovery in the CDS market. According to these researchers, the superior ability of traders to process information in the CDS market means that the CDS market has a larger price discovery function than equities.

Lee et al. (2018) examined rating events on US public and private entities during the 2001-2013 time period. These authors documented that CDSs' spreads contributed significantly to price discovery in financial markets when firm-specific credit information was prominent. According to them, CDS prices contain unique firm credit risk information that is not captured by prices of other related securities, such as stocks of the same firm, and thus that CDS returns significantly predict stock returns. These authors also mention that the firm-specific information flow from CDSs to stocks is stronger for reference entities that have established strong lending relationships with primary CDS dealers who could generate endogenous hedging demand in the credit default market. When market conditions were effectively controlled for and firm-specific information is sharply identified in stock and CDS returns, CDS returns contributed to price discovery above and beyond the information contribution from stock returns. According to these authorities, the CDS cross-section is also differently targeted by different clients whose trading motives depend on the availability of private information. This private information and trading on it could explain why CDSs lead stock prices.

According to Marra et al. (2019), who examined the impact of trade reporting and central clearing on CDS price informativeness by using a sample of five-year CDS contracts written on 744 US reference entities over the period January 2001 to December 2013, documented that positive CDS innovations predict future stock returns in the proximity of credit events. Yet, these authors documented that the predictability of CDS prices for equity prices fell after the reporting by the Depository Trust & Clearing Corporation (DTCC) began[17] and voluntary central clearing started for the cleared reference entities. Mateev (2019) subsequently investigated the relationship between the volatility of CDSs and stock prices using a sample of 109 European investment-grade companies from January 2012 to January 2016. This author found evidence that the volatility spillover was bi-directional with the predominant leadership of the European CDS market over the stock market. Procasky (2021) used a sample of equity and CDS prices from 29 November 2004 to 18 September 2015 in the US and illustrated that the CDS market was more efficient under adverse market conditions. According to this author, equity prices can be predicted based on the information from the CDS market although such predictability does not last beyond one trading day.

Silaghi et al. (2022) analysed the reaction of the CDS market to loan renegotiation announcements using a sample of 758 renegotiations of public US firms covering the period from January 2010 to December 2017. They found a significant decrease in CDS spreads for

[17] Starting from November 2008, the Depository Trust & Clearing Corporation (DTCC) began to register CDS trades in its Trade Information Warehouse (DTCC-TIW), makes data reported by traders available to the Securities and Exchange Commission (SEC), and publishes weekly aggregate trade data for the top 1000 most active single-name CDSs.

almost all types of loan amendments and found a negative reaction on the stock market but barely statistically significant. They found evidence of an anticipation effect in the CDS market of up to 30 days before the announcement date, which they explain by the fact that CDS banks are generally better informed. Additionally, Boussada et al. (2022) investigated the European CDS spreads and their relationship to other financial assets such as stock indices, thereby using daily data covering the period from January 2004 to December 2018. They found a significant unidirectional causality from CDS spread changes to stock market indices returns.

In contrast to the aforementioned literature, many academic studies found a relationship in the opposite direction. Norden and Weber (2009), for example, examined weekly and daily lead-lag relationships and the adjustment between markets caused by cointegration during the period 2000-2002 using a sample of 90 firms from Europe, the United States, and Asia. These authors found that stock prices led CDS spreads. The effect was stronger for US than for European firms. Forte and Peña (2009), using a sample of 17 North American and European non-financial firms over the period 12 September 2001 – 25 June 2003, found evidence that stocks lead CDSs more frequently than the other way around. Trutwein and Scheireck (2011) examined the link between equity and credit markets for major financial intuitions focussing on sizeable US firms that either failed or required substantial government supporting during 2008. Based on a daily lead-lag relationship of 5-year CDSs, equity prices, and implied option volatility, they document that equity price changes led to furious CDS spread changes and that equity and credit markets became more integrated during times of heightened stress.

Giannikos et al. (2013) explored whether CDSs' lead stocks of 10 US financial firms before and during the crisis of 2008 using a cointegration framework. They found stock markets to be more informative than the CDS market. These scholars found that before 2008, two-thirds of price discovery occurred in the equity market and about one-quarter in the CDS market. Through 2008, the influence of stocks dropped to about 50%. Hilscher et al. (2015) examined five-year CDS contracts of the most liquid US firms for the period January 2001 to December 2007 and concluded that equity returns led CDS returns at daily and weekly frequencies, but not vice versa. They interpreted these results as evidence of the presence of informed traders in the equity market and the general absence of informed traders in the CDS market. According to them, most trading in CDS contracts is primarily motivated by liquidity considerations. Their results are inconsistent with the possibility that CDS trading amplifies shocks in the equity markets via a feedback mechanism because CDS returns do not seem to predict equity returns.

Marsh and Wagner (2016) then found that for the US over the period 1 January 2004 to 14 October 2008, equity markets only led CDS markets following aggregate positive news, although not following negative or neutral news. They argued that the equity market and CDS market have different investor groups. That is, a wide range of investors with very diverse trading interests are active in equity markets, while participation in the CDS market is much more limited. For instance, hedgers in the CDS market are likely to be already well informed about news specific to the firms in their portfolio, compared to equity dealers focussing more likely on macroeconomic news. In response to positive equity market news, dealers in the CDS market can keep prices high and exploit their informational advantage, which dampens price adjustments in the CDS market and causes an equity-lead specific to positive macro news. Kiesel et al. (2016) assessed the market integration and efficiency of CDSs and equity markets by examining the CDS spreads of 538 US and European firms around sudden and unanticipated credit events from 2010 to 2013. They documented that stock markets reacted before CDS markets, anticipating credit events earlier. Specifically, equity returns incorporated the credit events two days earlier thereby influencing the observed CDS spread change on the day of the credit event, indicating that both markets are not fully integrated.

Tolikas and Topaloglou (2017) collected daily closing midpoint spreads of CDS indices over the period from 1 January 2008 to 30 June 2014 focussing on four geographical regions (i.e. North America, Europe, UK, and Asia) and nine economic sectors (i.e. banks, consumer goods, electric power, energy manufacturing, other financials, service, communications, and transportations). They found significant evidence in all regions and economic sectors that the stock market led the price discovery process, thereby reflecting default risk faster than in the CDS market. They also found evidence that the documented lead-lag relation was not regime-dependent and was stronger for negative stock market news. Furthermore, Shahzad et al. (2017) examined the link between US industry-wise credits and stock markets focussing on eleven industries (i.e. banks, financial, telecommunications, healthcare, oil and gas, materials, consumer goods, utilities, industrial, consumer services, and technology) over the period 14 December 2007 to 31 December 2014. They showed that the stock market impacted the CDS counterparties and there existed a bidirectional causality for the banking, healthcare, and material industries. They highlighted that business conditions, stock market volatility, default premiums, treasury bond rate, and the slope of the yield curve were major drivers of the CDS-stock nexus. Jitmaneeroj (2018) then examined for Thailand for the period 2008-2015 whether there was a lead-lag relationship between the five-year CDS spreads and the equity prices of 6 listed companies. He found that stock markets indeed led CDS markets.

Da Fonseca and Gottschalk (2020) provided a comprehensive analysis of the co-movement of CDSs, equity, and volatility markets in four Asia-Pacific countries at firm and index level during the period 2007-2010. At the firm level, equity returns led changes in CDS spreads and realized volatility. At the index level, these scholars detected no clear intertemporal linkages between the markets. Wang et al. (2023) analysed firm-level return data from the US equity and CDS markets between January 2003 and July 2017. They showed that before the Great Financial Crisis, the information flow was unidirectional with equity returns leading CDS returns. Equity returns continued to lead CDS returns after the crisis but the speed of adjustment from CDS markets to equity markets increased during that period. CDS spreads responded quicker to equity returns during the post-crisis period mainly among entities with lower credit ratings. Related to this research, Bratis et al. (2023) examined core (Germany, France) and periphery (Portugal, Italy, Ireland, Spain, Greece) EMU countries for the 2009-2014 period. They documented that before the EMU debt crisis (2008-2009), the information flow started from the equity towards the CDS market but turned bidirectionally post-debt crisis (2010-2014). Manicaro (2023) analysed volatility connectedness at sectoral and regional levels within and across the UK, UK, EU, and Japanese regions between the CDS and equity markets. For this analysis, this scholar examined 32 sectors with each having almost 2,500 observations, covering the period between 2008 and June 2017. This scholar found evidence that connectedness between the two asset classes was higher during a crisis period, where equity was the asset class that transmitted volatility the most.

Besides the aforementioned studies that found a significant directional pattern between the CDS market and the stock market, several studies found that the relationship between them is even more complex as the relationship depends on multiple parameters, is no always prevalent, or can even change direction. For instance, Fung et al. (2008) examined the market-wide relations between the US stock market and the CDS market for the period 2001-2007 and found that a mutual feedback loop between the stock and CDS markets existed. Their results indicated that the lead-lag relationship between the US stock market and the CDS market depended on the credit quality of the underlying reference entity. That is, information spread from the stock market to the high-yield CDS market in terms of pricing and volatility, while the stock market led the investment-grade CDS index in the pricing process. Yet, volatilities of both the investment-grade and high-yield CDS indices seemed to lead the stock market volatility, while the latter had no feedback effect to that of the high-yield CDS market only. These authors then also advised market participants to examine information in both markets in case they want to engage in trading. Flannery et al. (2010) examined whether CDS spreads could act as substitutes for credit ratings thereby focussing on the CDS spreads of fifteen large financial institutions that were prominently involved in the great financial crisis. They documented that from 2006 through 2009, CDS spreads incorporated new information about as quickly as equity pries and significantly more quickly than credit ratings. This is in line with Hull et al. (2004) and Norden and Weber finding strong evidence that the CDS spreads anticipated credit rating announcements, particularly negative rating events. Hence, according to Flannery et al (2010), there is no such thing as a lead-lag relationship.

According to Forte and Lovreta (2015), who analysed the stock and the CDS market during the period 2002-2008 for 643 European reference entities, the stock market's informational dominance reported in previous studies holds only in times of a financial crisis. During tranquil times, the CDS market's contribution to price discovery is similar or even higher than that of the stock market. Santamaria et al. (2014) then examined the relationships between the markets for sovereign CDSs, sovereign bonds, and equity for thirteen European countries during the period 2008-2012. During the 2008-2009 period, equity markets seemed to lead the process of incorporation of new information but during 2010 this leading role was assumed by sovereign CDS markets. This finding suggests a private-to-public risk transfer during the subprime crisis and a reversal to a public-to-private risk transfer during the sovereign debt crisis. Ballester and Gonzalez-Urteaga (2020) examined stock indices and sovereign CDSs for 14 European countries and the US over the period 2004-2016. They observed that stock market returns anticipated sovereign CDS returns and sovereign CDSs anticipated the conditional volatility of equity returns, closing a connectedness circle between markets. Within Europe, a greater impact in Eurozone countries compared to non-Eurozone countries could be observed.

A recent study by Procasky and Yin (2023a) confirmed that the cross-market information flow between CDS and equity markets is complex and not simply one-way. Examining daily data from 2004 to 2019 from the CDX.NA.IG (i.e. US), the authors apply a time-varying coefficient vector autoregression technique. This technique allows for examination of information flow during different time periods using time-varying rather than constant model coefficients. The authors observed a two-way interactive effect, as well as structural breaks in the level of this information flow.

Finally, it is worth highlighting research specifically examining the relationship between different asset classes during and after the COVID-19 period. As shown by for example Bouri et al. (2021), it appears that there is a change both in structure and in the time-varying patterns of return connectedness across various asset classes, such as equities, bonds, commodities, and currencies, since the start of the COVID-19 outbreak. It shows, amongst others, a speedier and stronger connectedness as well as a change in primary transmitters of shocks from equity (indices) to bond (indices). The increased level of connectedness is attributed to a higher level of stress generally in financial markets during the pandemic. Indeed, Procasky and Yin (2023b) build on their previous work (Procasky and Yin 2023a; supra) and show there has been structural change from the start of the outbreak in information flow in US equity markets and in related (high yield) CDS markets. Overall, the authors find that this change was more severe in equity markets, with CDS markets having an overall information advantage.

4.2. Do CDS spreads lead bond prices?

As regards the question of whether the single-name CDS market leads or lags the bond market, empirical evidence (see Table 2) is more consistent across different studies and data samples and supports the conclusion that CDSs lead corporate bonds in price discovery.

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Insert Table 2 about here
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For instance, using a sample of CDS and bond prices on reference entities located in the US, UK, Germany, Spain, Italy, France, and Sweden over the period January 2001-June 2002, Blanco et al. (2005) found that the CDS market led the bond market and the CDS market contributed to on average around 80% of the price discovery. These authors further documented that the CDS market reacted more rapidly and severely to negative shocks compared to positive ones. The CDS reactions to negative shocks occurred even before the events were revealed to the public; a finding later confirmed by Huang et al. (2012). Zhu (2006) focussed on 1,400 reference entities over the period 1 January 1999 to 31 December 2002. This author found that the CDS market mostly moved ahead of the bond market. Yet, there seemed to be a certain degree of market segmentation in the CDS market between the US and other regions, including the choice of risk-free rates and dynamic interactions. That is, the derivative market led the cash market in price discovery in the US market but not in the other regions in the sample.

Norden and Wagner (2008) examined the relation between CDS spreads and banks' pricing of syndicated loans to US corporates during the period 2000-2005. They found that changes in CDS spreads explained about 25% of subsequent monthly changes in aggregated loan spreads. Even more, compared to traditional explanatory factors, CDS spreads turned out to be the dominant determinant of loan spreads. According to these authors, CDS prices thus contain, beyond general credit risk, substantial information relevant to bank lending. Over time, new information appears to be incorporated faster into the CDS markets than into loans. Baba and Inada (2009) analysed the subordinated bond and CDS spreads for Japanese mega-banks during the period from 2 April 2004 to 30 December 2005. They documented that the subordinated bond and CDS spreads were cointegrated in most cases but that the CDS spread played a more dominant role in price discovery than the bond spread. They also documented significant volatility spillovers from the CDS to bond spreads. Examining North American and European non-financial firms over the period 12 September 2001 to 25 June 2023, Forte and Pena (2009) confirmed this finding that the CDS market led the bond market. Norden and Weber (2009) further examined weekly and daily lead-lag relationships and the adjustment between markets caused by cointegration during the period 2000-2002 using a sample of 90 firms from Europe, the United States, and Asia. They documented that CDS spread changes caused bond spread changes for a higher number of firms than vice versa. The CDS market thus seemed to contribute more to price discovery than the bond market and this effect was stronger for US than for European firms.

According to Delis and Mylonidis (2011), focussing on Southern European Countries (i.e. Greece, Italy, Portugal, and Spain), CDS prices caused bond spreads after the eruption of the 2007 sub-prime crisis, thereby indicating that high-risk aversion tends to perplex the transmission mechanisms between CDS prices and government bond spreads. Ammer and Fang (2011) examined the relationships between CDS premiums and bond yield spreads for nine emerging market sovereign borrowers over the period 26 February 2001 to 31 March 2005 and found evidence that CDS premiums often moved ahead of the bond market but that bond spreads led CDS premiums for emerging market sovereigns more often than has been found for investment-grade corporate credits. The CDS market was also less likely to lead sovereigns that had issued more bonds. Aktug et al. (2012) examined the dynamic relationship between sovereign CDSs and bond markets over the period 2001 to 2007 across 80 countries of which 30 emerging ones. They showed that the CDS market played a dominant role in lead-lag relationships. Using data on sovereign CDSs and bond markets in Western Europe over the period 1 January 2008 to 27 July 2010, Delatte et al. (2012) found that the CDS market determined the bond markets. Additionally, the higher the distress of the underlying reference entities was, the more the CDS market dominated.

Coudert and Gex (2013) constructed a sample of CDS premia and bond spreads on a generic 5-year bond for seventeen financials and 18 sovereigns during the great financial crisis and found that the CDS market led the bond market in the case of financial institutions. This was also the case for high-yield sovereigns, but the reverse was found for low-yield sovereigns in the core of the euro area. According to these authors, this finding can be interpreted according to the relative liquidity of both markets for different types of entities. The CDS market's lead was also amplified when default risk increased, during crisis periods, as well as contiguously when CDS premia increased. Arce et al. (2013) then analysed the extent to which prices in the sovereign CDS market and bond market reflect the same information on credit risk in the context of the crisis of the European Monetary Union. Based on a dataset from the period 2004-2012 for 11 European countries, they found that deviations between CDS and bond spreads were related to counterparty risk, common volatility in equity markets, market illiquidity, funding costs, flight-to-quality, and the volume of debt purchased by the European Central Bank in the secondary market. In other words, the level of counterparty risk and the common volatility in equity markets together with the banks' agreement to accept losses on their holdings of Greek bonds impaired the ability of the CDS market to lead the price discovery process. Using data on 16 actively traded five-year CDS with underlying bonds issued by large US corporations over the period 1 July 2009 to 30 June 2010, Lien and Shreshtha (2014) found evidence that for the majority of cases, price discovery took place in the CDS market.

Fontana and Scheicher (2016) used weekly data over the period January 2007 to December 2012 to examine the market pricing of euro area government bonds and the corresponding CDSs. They found that both CDSs and bond spreads correlated positively with measures of risk premium but that CDSs exhibited a stronger correlation with country-specific drivers of credit risk. Put differently, since the outset of the sovereign debt crisis, the bond market had a predominant role in price discovery in Germany, France, the Netherlands, Austria, and Belgium, while the CDS market played a major role in Italy, Ireland, Greece, and Portugal. Lee et al. (2018) examined rating events on US public and private entities during the 2001-2013 time period. According to them, credit information unidirectionally flowed from CDS to bonds, particularly for private entities whose stocks were not currently trading in markets. According to these authors, CDS spreads thus contained unique information that was not captured by bonds. This unique CDS market information on future rating changes was explained by the bank-related informed trading that created endogenous liquidity provision in the CDS market. Gintelberg et al. (2018) investigated the effect of the European ban on naked CDS trading on the price discovery process of sovereign credit risk. Using intraday data on sovereign CDSs for several European countries and bonds they found that the CDS market dominated the bond market in terms of price discovery. The CDS premia adjusted quicker to new information compared to bond spreads, even when taking transaction costs into account. The ban on short-selling did not alter price discovery dynamics or reduce the efficiency of the CDS market.

Tampakoudis et al. (2019) examined the lead-lag relationship between sovereign credit default swaps and bond spreads of the highly indebted southern European countries (i.e. Portugal, Italy, Greece, and Spain) and two core Eurozone countries (i.e. France and Austria). The sample period for Portugal, Italy, France, and Austria ran from January 2006 to March 2015. In the case of Spain, the sample period covered October 2006 to March 2015, while for Greece the sample period began in January 2006 an ended in September 2011 due to a lack of data availability and missing observations. They found that during periods of economic turbulence, the CDS market led the bond market in price discovery, incorporating new information about sovereign credit risk factors more effectively than the bond market did. Raja et al. (2020) focussed on eight sovereign emerging markets (i.e. Brazil, Colombia, Mexico, Panama, Peru, Russia, Turkey, and Venezuela) over the period from January 2006 till April 2016 and found that CDS dominated bonds in pricing of emerging market sovereign credit risk. One exception was during the financial crisis, suggesting that when panic hits, sovereign markets price credit risk differently. Yet even in that situation, the CDS market had a greater impact on price discovery than the bond market. Anelli and Patane (2022) analysed the dynamic relationship between the CDS premia and the government bond spreads concerning sovereign credit risk. Their results indicated that since the Lehman Brothers collapse, the CDS market has been leading the bond market incorporating more rapidly the sovereign credit risk information. This finding holds, however, only in Spain. The opposite dynamic is observed for Portugal, Italy, and Ireland.

5. CONCLUSION AND DISCUSSION

This paper provides an extensive literature review on whether single-name CDS markets lead equity and bond prices. Under the caveat that previous studies are based on historical data, which does not warrant to see similar future market evolution, it helps to understand whether single-name CDS generally steer equity and bond markets. If this is indeed the case, it is definitely recommended to further examine empirically whether it is highly probable CDS market participants in March 2023 steered equity and bond prices of major global systemically financial institutions like Deutsche Bank and UBS. Indeed, regulators and media are concerned whether an opaque and illiquid derivative market can be used by CDS market participants to impact the stock and/or bond price of such reference entities. Simply observing these evolutions in financial instrument's data cannot lead to any general conclusions for such a specific individual case: there is no access to intraday and/or microstructure data, and compounding factors are not controlled for. Hence, this paper does not purport to put forward irrefutable evidence on whether CDS participants steered equity or bond prices via CDS transactions, as no data was available for this research, but rather whether reasonable chance based on the existing empirical literature that exists to date. This paper can thus be considered as an extensive research review where conclusions might be a helpful starting point for further empirical research to delve into in this case.

Examining the literature on whether CDS spreads drive bond prices, previous literature is conclusive and supports the view that CDS markets lead bond markets in price discovery. When analysing the literature on whether CDS spreads drive stock prices or vice versa, results are inconclusive with practically as many studies finding a lead-lag from CDS spreads to stock prices as vice versa. Looking at these studies in detail, it appears that the choice of US, EU, or Asian markets alone cannot explain the different findings: opposite results can be found amongst studies focussing on the same geographical area. The argument that US markets are thus more liquid both for CDS and equity markets compared to EU markets, and therefore different patterns can be found between US and EU studies does not seem to hold. This article thus comes to a different conclusion than Culp et al. (2016), who claimed that the inconsistency between findings is caused by differences in equity and CDS markets in the US and Europe due to differences in regulations and market microstructures. Moreover, whether the analyses were performed on data pre- or post-2008 alone does not appear to have much influence, as this article finds contradicting studies using data before the great-financial crisis as well as after it. The impact of various regulations introduced after the financial crisis, or whether the CDS market was more liquid in the past compared to nowadays, does therefore not appear to be sufficient to explain the difference. One could have made the argument that for more liquid markets, which the CDS market used to be, information is incorporated much faster. It should be noted, however, that the large majority of studies focused on the period around the financial crisis.

Furthermore, whether the reference entities are active in a particular sector cannot help to explain the difference in findings. Both research finding CDS spreads drive equity price and vice versa, contain examples of both corporate as well as sovereign borrowings, and with detailed analyses on whether the corporate entities are active in the financial industry or not. Additionally, this appears to suggest that both the level of adverse selection risk, or whether a reference entity is active in a strongly regulated sector, apparently have no impact the directional relationship. Furthermore, the used data source provides little explanation for the difference in findings, given that Bloomberg, CreditTrade, Markit, and Thomson Reuters are mostly used, both in the studies that find that CDS spreads drive equity prices, and vice versa. In addition, the main applied methodology is no explanatory factor either, arguing against the claim of Shahzad et al. (2017). Indeed, most studies rely on vector autoregressive models (VAR), vector error corrected models (VECM), or OLS regression models but find contradictory findings. Finally, whether the reference entities in the sample have a high default risk does not appear to explain the difference in findings either given that there are studies that claim that the CDS market leads the equity market, as well as studies documenting the opposite, for reference entities entering into bankruptcy or being downgraded.

In any case, the question thus remains: what can explain the differences in findings? Further research could examine whether the samples that were applied were different in terms of the counterparty credit risk of the counterparties being active as well as the market capitalization of the reference entities, being another proxy for adverse selection and size. These variables might namely impact the incorporation of new information in security prices. In addition, most existing research focussed on five-year CDSs as these are most liquid. It could be further examined whether results would be more conclusive for other tenors, under the caveat that the other tenors tend to be very illiquid and less useful for price discovery purposes. Furthermore, future research could examine whether the inclusive conclusions were driven by different types of information that was processed. Indeed, the equity market could incorporate faster market-wide information and common risk factors compared to the CDS market, while the opposite might be true for information that is reference entity-specific (see Marsh and Wagner, 2012). Furthermore, one might analyse if there is a difference based on whether the new information regarding the underlying reference entity is positive or rather negative. Additionally, as the credit spread encompasses also the probability that the protection seller itself could default, future research could examine whether previous studies on the lead-lag relationship between CDS spreads and equity prices are inconclusive because the samples have different protection sellers having a divergent level of default risk. Finally, as per Procasky and Yin (2023b), it might well be the case that the relationship is simply rather complex, not one-way but both-ways, and changing over time: in this case, more focused studies, rather than large generic studies, could be helpful.

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Table 1 Overview of the literature on whether CDS spreads lead equity prices or vice versa

CDS spreads lead stock prices					Stock prices lead CDS spreads				
Authors	**Period**	**Geographical regions**	**Data source for CDSs**	**Main Methodology**	**Authors**	**Period**	**Geographical regions**	**Data source for CDSs**	**Main Methodology**
Lake and Apergis (2005)	2004-2008	US, Germany, UK, and Greece	Bloomberg	VECM-model + MVGARCH-M model	Norden and Weber (2009)	2000-2002	US, EU and Asia	CreditTrade and a large (anonymous) European bank.	VAR-model / VECM-model
Archarya and Johnson (2007)	2001-2004	US	CreditTrade	Seemingly unrelated regressions	Forte and Peña (2009)	2001-2003	US and EU	Banco Santander	VECM-model
Jorion and Zhang (2007)	2001-2004	US	Markit	Event study / OLS panel regression	Trutwein and Scheireck (2011)	2001-2003	US	Markit	VAR-model
Chan et al. (2009)	2001-2007	China, Japan, Korea, Indonesia, Malaysia, the Philippines, and Thailand	Markit	VECM-model / VAR-model	Giannios et al. (2013)	2005-2008	US	Bloomberg	VECM-model
Qiu and Yu (2012)	2001-2008	US	Markit	OLS panel regression	Hilscher et al. (2015)	2001-2007	US	Markit	VAR-model
Eyssell et al. (2013)	2001-2010	China	Markit	VAR-model	Marsh and Wagner (2016)	2004-2008	US	Markit	VAR-model
Rodriguez-Moreno and Pena (2013)	2004-2009	US and EU	Thompson Reuters	Granger causality test	Kiesel et al. (2016)	2010-2013	US and EU	Thomson Reuters	Event study/ OLS panel regression
Xiang et al. (2013)	2005-2009	US	CreditTrade	VECM model	Tolikas and Topaloglou (2017)	2008-2014	US, EU, UK, and Asia	Thomson Reuters	VAR-model
Amadori et al. (2014)	2003-2010	EU	Thomson Reuters	Seemingly unrelated regression	Shahzad et al. (2017)	2007-2014	US	Thomson Reuters	VAR-model
Narayan (2015)	2004-2012	US	Bloomberg	VAR-model + GVAR model	Jitmaneeroj (2018)	2008-2015	Thailand	Thomson Reuters	VAR-model + PVAR model
Kryzanowski et al. (2017)	2009-2013	US	Markit	OLS panel regressions	Da Fonseca and Gottschalk (2020)	2007-2010	Australia, Japan, Korea, and Hong Kong	Markit	VAR-model
Lee et al. (2018)	2001-2013	US	Markit	VAR-model	Wang et al. (2023)	2003-2017	US	Markit	VAR-model
Marra et al. (2019)	2001-2013	US	Markit	OLS panel regression	Bratis et al. (2023)	2009-2014	Germany, France, Portugal, Italy, Ireland, Spain and Greece	Thomson Reuters	VAR-model
Mateev (2019)	2012-2016	EU	Markit	DCC-GARCH model + BEKK-GARCH model	Manicaro (2023)	2008-2017	US, UK, EU, and Japan	Thomson Reuters	GFEVD-model + VAR-model
Procasky (2021)	2004-2015	US	Markit	VAR-model / VARMA model					
Silaghi et al. (2022)	2010-2017	US	Thomson Reuters	Event study / OLS panel regression					
Boussada et al. (2022)	2004-2018	EU	Bloomberg + Thomson Reuters	DCC-MGARCH model + C-MGARCH					

Table 1 (cont) Overview of the literature on whether CDS spreads lead equity prices or vice versa

Other				
Authors	**Period**	**Geographical regions**	**Data source**	**Methodology**
Fung et al. (2008)	2001-2007	US	Markit	VAR-model
Flannery et al. (2010)	2006-2009	US	Markit	OLS panel regression
Forte and Lovreta (2015)	2002-2008	EU	GFI	VECM-model / VAR-model
Santamaria et al. (2014)	2008-2012	EU	Bloomberg	VAR-model
Ballester and Gonzela-Urteaga (2020)	2004-2016	US and EU	Thomson Reuters	VAR-model
Procasky and Yin (2023a)	2004-2019	US	Markit and CRSP	DVAR-model
Procasky and Yin (2023b)	2020-2022	US	Markit and CRSP	VAR-model

Table 2 Overview of the literature on whether CDS spreads lead bond prices or vice versa

CDS spreads lead bond prices				
Authors	**Period**	**Geographical regions**	**Data source for CDSs**	**Main Methodology**
Blanco et al. (2005)	2001-2002	US, UK, Germany, Spain, Italy, France and Sweden	CreditTrade	VECM-model / VAR-model
Zhu (2006)	1999-2002	US, EU, and Asia	CreditTrade	VECM-model / VAR-model
Norden and Wagner (2008)	2000-2005	US	CreditTrade and one large anonymous universal bank	VECM-model
Baba and Inada (2009)	2004-2005	Japan	CreditTrade	VECM-model / VAR-model
Forte and Pena (2009)	2001-2023	US + EU	Banco Santander	VECM-model
Norden and Weber (2009)	2000-2002	US, EU, and Asia	CreditTrade and a large (anonymous) European bank.	VAR-model / VECM-model
Delis and Mylonidis (2011)	2004-2010	Greece, Italy, Portugal, and Spain	Bloomberg	VECM-model
Ammer and Fang (2011)	2001-2005	Brazil, China, Colombia, Mexico, Philippines, Russia, Turkey, Uruguay, and Venezuela	Markit	VECM-model
Aktug et al. (2012)	2001-2007	80 countries, of which 30 emerging	Markit	VECM-model
Delatte et al. (2012)	2008-2010	Austria, Belgium, Denmark, France, Greece, Ireland, Italy, Netherlands, Portugal and Spain.	Bloomberg+ Thomson Reuters	VECM-model
Arce et al. (2013)	2004-2012	Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, and Spain.	Credit Market Analysis	OLS panel regression + VECM- model
Coudert and Gex (2013)	2007-2010	Argentina, Austria, Belgium, Brazil, Denmark, Finland, France, Lithuania, Mexico, the Netherlands, Greece, Ireland, the Philippines, Poland, Portugal, Spain, Turkey, the UK, and the US.	Bloomberg	VECM-model
Lien and Shrestha (2014)	2009-2010	US	Thomson Reuters	Generalized information share model.
Gintelberg et al. (2018)	2008-2014	France, Germany, Greece, Ireland, Italy, Portugal, and Spain	Credit Market Analysis	VECM-model
Lee et al. (2018)	2001-2013	US	Markit	VAR-model
Tampakoudis et al. (2019)	2006-2015	Portugal, Italy, Greece, Spain, France and Austria	Bloomberg	VECM-model / VAR-model
Raja et al. (2020)	2006-2016	Brazil, Colombia, Mexico, Panama, Peru, Russia, Turkey, ad Venezuela	Bloomberg	VECM-model/ PST-ECM model
Anelli and Patane (2022)	2007-2017	Portugal, Ireland, Italy, Greece, and Spain	Bloomberg	VECM-model.