

Essays on Corporate Growth and Corporate Credit Risk

Mehmet Caglar Kaya

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DOCTORAL DISSERTATION

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Abstract This doctoral dissertation contributes to research on financial economics. It consists of an overall introduction and three independent papers. The first paper, "<i>A Theory of Gazelle Growth: Competition, Venture Capital Finance, and Policy</i>," examines how young fast-growing small firms, called gazelles, develop. The paper investigates under which circumstances gazelles grow by establishing a new facility organically or by acquiring another firm. The paper proposes a theoretical model in which a gazelle firm competes against an incumbent firm that is a market leader in an oligopolistic market. The paper shows that a lower cost of organic growth can increase the gazelles' incentives for acquisition growth. This is because the incumbent cannot in this situation protect its market from the gazelle's entry and therefore does not acquire the target firm for entry-detering purposes. Therefore, the gazelle firm can acquire the target firm at such a low price that it prefers growth by acquisition over organic growth. This effect implies that regulators' financial policies customized to support the gazelles' organic growth may, instead, spur gazelles to grow through acquisitions. The second paper, "<i>Tracing Credit Risk in the Equity Market</i>," analyzes empirically how the illiquidity of a firm's stock in the equity market affects the firm's credit risk in the debt market. The paper measures credit risk via credit default swap (CDS) spreads. According to the Efficient Market Hypothesis, the stock price should reflect all available information. Similar to stock return or stock return volatility, stock liquidity is another aspect of stock price that provides information to the market about a firm's value and future performance. This paper hypothesizes that stronger information asymmetry about the firm's value will manifest itself as a higher illiquidity of the firm's stock in the equity market. The CDS market will interpret higher illiquidity as a higher credit risk of the firm, and this will increase the CDS spread for the firm. The paper uses a sample of publicly owned large North American non-financial firms and shows that the higher the illiquidity of a firm's stock, the higher the CDS spread of the firm in the next fiscal quarter. The third paper, "<i>How Does Debt Composition Influence Credit Risk?</i>," examines how different types of debt in a firm's capital structure affect its credit risk. This paper uses CDS spreads to measure firms' credit risk and decomposes debt according to two classifications: account type and debt maturity. Every debt type has its characteristics and implies a different level of information asymmetry in the credit relationship between the firm and its lender. Therefore, this paper hypothesizes that the CDS market attributes a different level of credit risk to each debt type. Empirically, the study finds that debt to financial markets is the most influential in terms of economic magnitude on next quarter's CDS spread among all debt types by account type classification. Regarding debt maturity classification, the paper concludes that the CDS market attributes more credit risk to long-term than short-term debt.		
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To My Family

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Abstract

This doctoral dissertation contributes to research on Financial Economics. It consists of an overall introduction and three independent papers on corporate growth and corporate credit risk.

The first paper, “*A Theory of Gazelle Growth: Competition, Venture Capital Finance, and Policy*”, examines how young fast-growing small firms, called gazelles, develop. The paper investigates under which circumstances gazelles grow by establishing a new facility organically or by acquiring another firm. The paper proposes a theoretical model in which a gazelle firm competes against an incumbent firm that is a market leader in an oligopolistic market. The paper shows that a lower cost of organic growth can increase the gazelles’ incentives for acquisition growth. This is because the incumbent cannot in this situation protect its market from the gazelle’s entry and therefore does not acquire the target firm for entry-detering purposes. Therefore, the gazelle firm can acquire the target firm at such a low price that it prefers growth by acquisition over organic growth. This effect implies that regulators’ financial policies customized to support the gazelles’ organic growth may, instead, spur gazelles to grow through acquisitions.

The second paper, “*Tracing Credit Risk in the Equity Market*”, analyzes empirically how the illiquidity of a firm’s stock in the equity market affects the firm’s credit risk in the debt market. The paper measures credit risk via credit default swap (CDS) spreads. According to the Efficient Market Hypothesis, the stock price should reflect all available information. Similar to stock return or stock return volatility, stock liquidity is another aspect of stock price that provides information to the market about a firm’s value and future performance. This paper hypothesizes that stronger information asymmetry about the firm’s value will manifest itself as a higher illiquidity of the firm’s stock in the equity market. The CDS market will

interpret higher illiquidity as a higher credit risk of the firm, and this will increase the CDS spread for the firm. The paper uses a sample of publicly owned large North American non-financial firms and shows that the higher the illiquidity of a firm's stock, the higher the CDS spread of the firm in the next fiscal quarter.

The third paper, *"How Does Debt Composition Influence Credit Risk?"*, investigates how different types of debt in a firm's capital structure affect its credit risk. This paper uses CDS spreads to measure firms' credit risk and decomposes debt according to two classifications: account type and debt maturity. Every debt type has its characteristics and implies a different level of information asymmetry in the credit relationship between the firm and its lender. Therefore, this paper hypothesizes that the CDS market attributes a different level of credit risk to each debt type. Empirically, the study finds that debt to financial markets is the most influential in terms of economic magnitude on next quarter's CDS spread among all debt types by account type classification. Regarding debt maturity classification, the paper concludes that the CDS market attributes more credit risk to long-term than short-term debt.

Keywords: Gazelle Growth, Entrepreneurship, Acquisition, Competition, Venture Capital Finance, Policy, Credit Risk, Credit Default Swap, CDS Spread, Stock Illiquidity, Information Asymmetry, Market Interconnectedness, Capital Structure, Leverage, Credit Ratings, Accounting

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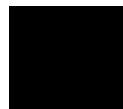
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Lund, Sweden, January, 2020
Mehmet Caglar Kaya

Introduction



Introduction

The first section of the introduction explains the background of this dissertation and how each paper contributes to the research in financial economics. Then, the second section provides a summary of each paper in the dissertation.

I Background and Contribution

Credit risk is a pervasive topic that both researchers of financial economics and practitioners in the business world aim to understand and manage through their best efforts. The global financial crisis in 2007-2008 can be characterized by an increased credit risk and the drying up of liquidity simultaneously across financial markets. I was working in the corporate credit risk unit of a large global bank when the financial crisis started in 2007. As part of an assessment unit assigned to evaluate and grant bank loans within the large corporations' segment, we needed to review the bank's all customer firms in its loan portfolio within a few weeks and re-assess their credit risk. At the time, what began as a mortgage crisis in the USA rapidly began to turn into a worldwide economic crisis. The finance world has swiftly learned that any crisis in one financial market might be contagious and spread rapidly to other financial markets, and a financial crisis that begins in one country might lead to a global economic crisis. The financial crisis has thus confirmed to us that different financial markets and different economies were already tightly interconnected with each other. This high level of interconnectedness led, almost simultaneously, to the drying up of liquidity across all markets. In addition to market interconnectedness, the global financial crisis has underlined the importance of understanding the factors creating and affecting credit risk, how to model credit risk most comprehensively, and developing tools to manage credit

risk wisely in a global interconnected financial world, as well as correctly evaluating the credit risk of the asset that makes up the underlying value for a financial instrument.

Another lesson that the global financial crisis reminded us of is the significance of providing enough finance with young small firms for economic growth. These young small firms play an essential role in society due to the employment opportunities they offer and their significant contribution to the generation of new products and innovative services. In turn, during any period of financial stagnation, young small firms are the first ones to be hit by a crisis. Therefore, it is of immense value to understand the growth of these firms and analyze the importance of financing for their sustainable growth. As a result, regulators may be able to address better and draw up new policies about how to aid and assist these firms. Improving current regulations so that young small firms can overcome their financial problems and continue long term activities that are critical for employment and economic growth seems to be of great value to society.

A key to handling the financial crisis better is understanding credit risk better. In the most general way, we can define credit risk as the potential hazard stemming from a possible loss when the obligor of a financial product or asset fails to fulfill contractual obligations in accordance with the agreed terms. For instance, the credit risk for a loan from a bank's perspective is the risk of the borrower firm's failure to repay the loan's principal amount and the interest payments on time. It is very challenging to assess and measure the credit risk of a financial instrument or a corporate loan. Credit risk usually does not exist in a vacuum and can be tightly connected to other risk types, such as market risk, liquidity risk, operational risk, or political risk. Most of the time, credit risk is fueled by other risk types. Moreover, measuring credit risk accurately is difficult because it also includes a default component called default risk, and defaults are usually infrequent events.

My work experience in the banking sector during the financial crisis has left me with great motivation to understand and better analyze credit risk in large corporations. How to measure credit risk better, tracing credit risk in the different markets to develop a more comprehensive assessment about it, and analyzing how credit risk depends on a firm's capital structure within the context of large corporations are the research topics that I have developed since my days in the business world, and my work experience motivated me to write this dissertation. In addition to these topics, observing small firms struggling with financial problems during fi-

nancial crises has also caught my attention and made me very interested in better understanding the implications of financing on firm growth within the context of small businesses in this dissertation.

The first paper (Kaya and Persson, 2019) focuses on the growth of young, high-growth small businesses. This paper provides a theoretical model of firm growth for these small businesses. In the proposed model, small firms can either grow organically or by acquisition while competing against a large incumbent firm in their markets. The theoretical model is then used to shed light on understanding the effects of regulations that are customized to support these small firms' organic growth. Most of these small firms require external financing to grow. Therefore, the model is also utilized to provide us with insights regarding how venture capital financing, one of the common types of funding that these young firms could attract, affects their growth. This paper contributes to the literature by showing that the lower cost of organic growth for small firms may increase the incentives for these firms to grow by acquisitions. The reason is that when the cost of organic growth for a small firm is low, the competitor incumbent firm's incentive to make any acquisition to deter the small firm's entry into the market decreases. This result implies that policies aiming to support the organic growth of these firms facilitate their acquisition growth instead. Furthermore, the theoretical analysis in this paper explains that some available financing modes, such as venture capital financing, lead these small firms to opt for growth by acquisition.

The second and third papers focus empirically on firm credit risk. In both papers, I measure credit risk by using corporate credit default swap (CDS) spreads. CDS is a financial instrument that is designed to provide a kind of protection against credit risk.¹ As Oehmke and Zawadowski (2016) define, CDS is a contract in which a seller agrees to make a payment to the buyer in the case of a credit event on a predetermined reference entity. The seller receives a periodic premium payment and potentially an upfront payment from the protection buyer.² A credit event referred to in a CDS contract might be bankruptcy, non-payment of debt, or debt restructuring. One can define CDS simply as an insurance contract written on the credit risk of the reference entity, and it allows investors to trade credit

¹The papers in this dissertation use only corporate CDS. Therefore, I will not use the "corporate" term again to differentiate a corporate CDS from a sovereign CDS which is a standardized instrument in which the contract value is based on the credit risk of a specific country.

²Readers who want to learn more about CDS and its market may consult the section called Background on Credit Derivatives and Credit Default Swaps in the second paper.

protection. I deliberately opt to use CDS spreads as a measure of credit risk due to many reasons. First, CDS is the most common financial instrument in which the underlying value is the credit risk of a firm. For instance, CDS contracts are traded more frequently than corporate bonds. Many studies in the literature also favor CDS spreads in comparison to bond spreads (Elton et al., 2001; Das et al., 2009; Ericsson et al., 2009). Second, CDS is the only financial derivative that provides daily information about the credit risk of a firm. Third, a CDS spread reflects the mutual view of many individual investors and participating financial institutions about the credit risk of a specific firm. Thus, a CDS spread conveys how the market assesses a firm's credit risk compared to what a group of analysts in a rating agency does (Norden, 2017).

The second paper aims to establish a new link between the equity market and credit market by analyzing the effect of the illiquidity of a firm's stock on its corporate credit risk measured via a CDS spread. The literature has already documented theoretically and empirically that stock return and stock return volatility impact credit risk (Merton, 1974; Zhu, 2006; Alexander and Kaeck, 2008; Fung et al., 2008; Greatrex, 2008). This paper contributes to the literature by assessing whether another aspect of stock price, namely stock illiquidity, also influences credit risk. According to the efficient market hypothesis (Malkiel and Fama, 1970), stock prices reflect all available information. The illiquidity of a firm's stock arises when the information asymmetry about a firm's value is high among investors. Information asymmetry feeds uncertainty about the firm's real value and earnings in the future. Increased uncertainty about anything related to the firm implies increased credit risk for the same firm. On the one hand, stock illiquidity is a publicly observable signal for the markets. On the other hand, credit risk is not that easily observable. The findings in this paper suggest that the stakeholders of a firm, such as investors, suppliers, customers, and banks, can be more informed in advance about the firm's credit risk when assessing the liquidity of a firm's stock, and thus these stakeholders can contract better with the firm and better manage the firm's credit risk to which they are exposed.

The third paper investigates the relationship between a firm's debt structure and its credit risk. In the finance literature, one of the important puzzles is how firms choose their capital structure. Through a better understanding of how different types of debt in a firm's capital structure impact its credit risk, we might be able to move forward in solving the capital structure puzzle that was introduced by Myers (1984) in his American Finance Association's (AFA) presidential address. The

current study contributes to answering this question by decomposing the leverage ratio into its components according to different debt types and debt maturity. Many studies in the literature have shown that the higher a firm's leverage ratio, the higher its credit risk (Merton, 1974; Altman, 1968; Ohlson, 1980; Ericsson et al., 2009; Zhang et al., 2009; Galil et al., 2014; Pires et al., 2015). However, it is yet to be analyzed whether different debt contracts or different maturities differ in their effects on corporate credit risk. The third paper now fills this gap. It divides a firm's debt into debt to financial markets, debt to banks, and debt to suppliers according to the standard accounting classification. It also separates the total debt amount to the parts of short-term debt and long-term debt according to maturity classification. Then, it evaluates the effect of each leverage component on the credit risk. The paper's empirical findings prove that each debt component contributes to a firm's credit risk distinctly to varying degrees, at least regarding the credit risk as perceived by the investors in the CDS market. This research advises financial regulators, investors, suppliers, customers, other stakeholders, and the firms themselves that the type and maturity features of indebtedness are as crucial as the amount of indebtedness. This study alerts us that some debt types, such as bank loans or trade credits might intensify credit risk to a lesser amount on good days, but we might have a different picture on bad days. Furthermore, this paper shows that firms can moderate their perceived credit risk by making changes in their debt structure.

2 The Overview of The Thesis

This doctoral dissertation consists of three papers presented in each section. The first paper in this dissertation contributes to the field of industrial organization. In turn, the second and third papers contribute to the field of corporate finance.

The first paper examines the growth pattern of young fast-growing small businesses and proposes a theoretical model that helps us understand which mode of growth those firms choose. The second paper delves into the phenomenon of market interconnectedness among different financial markets. It aims to establish another link between equity and debt markets through the concepts of illiquidity in the equity market and credit risk in the debt market. Finally, the third paper investigates the effect of different debt types in the capital structure of firms on their credit risk.

2.1 Paper I: A Theory of Gazelle Growth: Competition, Venture Capital Finance, and Policy

Coauthored with Lars Persson

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Societies rely heavily on small businesses in terms of employment and the generation of genuine ideas to create new products and services. At this point, especially young high-growth small firms, so-called gazelles³, have a substantial share in net employment growth and development of new products and services for our economies. Therefore, understanding and analyzing the growth of gazelles help us to address the challenges that these firms face and to develop suitable policies to enable their survival and facilitate their growth.

Gazelles need complementary assets such as distribution networks, financial resources, and manufacturing know-how to be sustainable and to maintain their development. In obtaining these assets, they are exposed most of the time to fierce competition with existing well-established firms, called incumbents, within their sectors. The first paper of this dissertation aims to analyze the growth of these young high-growth firms. It puts forward a theory of gazelle growth within an oligopolistic product market structure where a gazelle competes against an incumbent to obtain an asset as a resource needed for its survival and growth. The gazelle may either make its own investment for this asset and grow organically or acquire this asset directly. According to the model's theoretical framework, the paper differentiates which conditions lead a gazelle to organic growth and which ones motivate it to make an acquisition.

The model shows that a lower cost for organic growth can increase the incentives for the acquisition growth of a gazelle. This result, which is seemingly counter-intuitive at first glance, turns out to be a reasonable outcome in the model once we consider the competing incumbent's preemptive motives to protect its market against a gazelle. The lower cost of organic growth for a gazelle in the market persuades the incumbent not to block the development of the gazelle in any scenario. Therefore, the incumbent foregoes its acquisition of the complementary

³Henrekson and Johansson (2010) define "Gazelles" as young small firms that are associated with fast growth. These researchers added that such firms may exist in all industries, but their presence in the service sectors is more common.

asset needed by the gazelle. Then, the small high-growth gazelle is left alone in the competition and can acquire its target complementary asset at a lower price.

Furthermore, one of the most critical obstacles to a gazelle is the cost of financing its growth. The theoretical model in the paper proves that venture capital financing to a gazelle might reduce the incumbent's opportunity and motivation to impede the gazelle's growth by acquisition. Venture capital finance enables the gazelle to lower its organic growth cost, and the gazelle signals its improved financial capacity to the competitor incumbent. The incumbent then gives up its acquisition to impede the gazelle's growth. Therefore, venture capital support facilitates the gazelle's acquisition.

In regards to a policy perspective, the paper suggests that any financial policy aiming to support a gazelle's organic growth may, in fact, strengthen the gazelle's position in competing for a resource against an incumbent, and this policy may induce the gazelle to grow by acquisition rather than organically against the policy's goal.

2.2 Paper II: Tracing Credit Risk in the Equity Market

One of the critical lessons we gained from recent financial crises is that debt and equity markets are interconnected. This interconnectedness may help us to answer any question in one of these markets with the help of more available information in the other one. The financial crises have shown that the level of dependence among these markets is high, and the common factors affecting them both are numerous.

The second paper of my thesis is grounded in the concept of the markets' interconnectedness. The paper specifically investigates the relationship between the illiquidity of a firm's stock and the firm's credit risk proxied by the firm's credit default swaps (CDS) spread in the debt market, namely the CDS market. When market players have an increased level of information asymmetry about a firm's value, they refrain from trading any financial instrument written on the firm value, such as stock. A higher level of information asymmetry implies illiquidity in the firm's stock. Investors in both the stock market and the debt market interpret it as a sign of increased credit risk. Therefore, the paper hypothesizes that if a firm's stock has lower liquidity in the equity market, the firm's CDS spread in the credit market will be higher. The existing literature has demonstrated theoretically and empirically that stock prices and stock volatility influence the CDS spread of the

same firm in the debt market. Accordingly, we should expect that the stock liquidity, another moment of equity market, should also influence the same firm's CDS spread. The paper considers robustly four different measures of stock liquidity: namely, the bid-ask spread, the Amihud illiquidity, the turnover ratio, and zero-return days. It uses various measures because the liquidity of a financial instrument, particularly the liquidity of a stock, is a subtle concept in the sense that it is neither directly observable nor has a single aspect (Amihud, 2002).

The paper tests the relationship between stock liquidity in the equity market and the CDS spread in the debt market using a data set of publicly listed industrial firms in North America. The sample consists of data from 270 large corporations and covers the period between January 2004 and June 2016. The paper's empirical model, based on panel data analysis, employs the common credit risk determinants such as stock return, stock return volatility, market capitalization as a proxy for a firm's equity value, and income/asset ratio for a firm's profitability, as well as firm-fixed effects, time-fixed effects and industry-fixed effects while investigating the relationship between stock liquidity and credit risk.

As predicted, this paper confirms that the higher the illiquidity of a firm's stock, the higher the CDS spread of the firm in the next fiscal quarter. This result holds for all cost-based liquidity measures, i.e., the bid-ask spread, the Amihud illiquidity, and the zero-return days measure. However, the relationship does not exist statistically once the analysis measures stock liquidity with the turnover ratio that differs from other measures by not considering the price effect. The article also addresses the plausible endogeneity issue stemming from reverse causality by performing a quasi-instrumental variable (quasi-IV) analysis to the possible extent permitted by the data. In this quasi-IV approach, the paper removes the credit risk's effects that might be embedded in stock liquidity measures by using external credit ratings. Overall, the article shows supporting empirical evidence for the prediction that an increase in a firm's stock liquidity in the equity market leads to a decrease in its credit risk proxied by CDS spread in the debt market in the next fiscal quarter.

2.3 Paper III: How Does Debt Composition Influence Credit Risk?

Large corporations have different options regarding how to finance their assets, which depends on their financial strength, the specific industry conditions to which they are exposed, and the overall economic situation in the financial mar-

kets. Every financing mode has its advantages and disadvantages for firms. The reasons and factors that lead a firm to select one way of financing, among others, are different. Moreover, each debt type has its specific contract type, and it is associated with a different level of information asymmetry. Therefore, it is intuitive to expect that the effect on the firm's credit risk of each debt type in a firm's balance sheet may vary.

The third paper of this dissertation analyzes the debt structure of firms in terms of type and maturity and approaches the concept of firm leverage in terms of debt type and maturity rather than only debt amount while evaluating the effect of leverage on credit risk. The existing empirical literature has focused only on the amount of overall debt but overlooked the debt type while examining the impact of leverage on credit risk (Altman, 1968; Ohlson, 1980; Ericsson et al., 2009; Zhang et al., 2009; Galil et al., 2014; Pires et al., 2015). The paper fills this gap in the literature by empirically examining how different types of debt in a firm's capital structure affect the firm's credit risk proxied by a CDS spread.

The paper decomposes the leverage ratio into different components according to two types of classifications. The first classification relying on account type categorizes debt into debt to financial markets (commercial papers, bonds, etc.), bank debt, and trade credit. Then, the paper examines each specific component of the leverage ratio as market debt leverage, bank debt, and trade credit leverage ratios, respectively. The second classification relying on debt maturity divides the leverage ratio into two components: short-term debt leverage and long-term debt leverage ratios. In short, each debt type is a separate component of the leverage ratio. Every debt type has its own characteristics and includes a different level of information asymmetry in a firm's capital structure, as postulated by the pecking order theory (Myers and Majluf, 1984). Each debt type creates varying degrees of credit risk in the credit relationship between the firm and its lender. Therefore, this paper hypothesizes that the CDS market attributes a different level of credit risk to each debt type. The investors in the CDS market will assign high risk to market debt leverage, medium risk to bank debt leverage, and low risk to trade credit leverage. The paper tests this hypothesis by using a sample of 355 large public firms from North America operating in non-financial sectors. The sample covers a period from January 2003 to December 2017.

The main finding of the paper is that the market debt leverage ratio correlates more positively with the next fiscal quarter's CDS spread than the bank debt leverage and

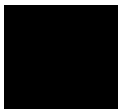
trade credit leverage ratios. The bank debt leverage ratio also has a positive effect on next quarter's CDS spread but to a lesser amount quantitatively. Regarding the trade credit leverage ratio, the paper documents that the trade credit leverage ratio raises the next quarter's CDS spread only for the firms operating in competitive sectors. By controlling the credit quality via the credit ratings in a robust study, the paper also deals with the endogeneity concern regarding the possibility of a causal relationship between leverage and credit risk, which can be the opposite of what has been argued in this paper, with a leverage ratio serving as a determinant of a CDS spread. Nevertheless, the findings of the paper remain robust.

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Paper 1





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A theory of gazelle growth: Competition, venture capital finance and policy[☆]

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ABSTRACT

This paper proposes a theory of gazelle growth in which gazelles can grow either organically or through acquisitions. The model includes three types of firms: incumbent, target, and gazelle. We show that the lower cost of organic growth can increase the incentives for acquisition growth because the incumbent understands that if it acquires the target firm, the gazelle will then invest organically in order to grow, and therefore, the acquisition will not be enough to protect the incumbent's market power. The gazelle could then acquire the target firm at a good price. We also show that financial support for the organic growth of gazelles can increase gazelles' growth through acquisitions because incumbents' preemptive motives are reduced.

1. Introduction

Due to their substantial share in net employment growth and their role in providing society with new products and services, young high-growth firms, or so-called gazelles, have attracted increasing interest from the literature, particularly in terms of understanding and analyzing their development (Birch, 1979; Henrekson & Johansson, 2010).

The starting point of this paper is the observation that gazelles¹ face considerable problems when trying to fully exploit the potential value of an invention or a business idea. Complementary assets such as distribution networks, marketing channels, financial resources, manufacturing know-how and brand names are typically held by large established firms, but these assets are also often needed by gazelles. To obtain these assets, the gazelles could either set up a new plant or warehouse and grow organically or acquire a target firm with these assets in place (Delmar, Davidsson, & Gartner, 2003; McKelvie, Wiklund, & Davidsson, 2006). However, many gazelles have to challenge large incumbent firms that are already market leaders competing in oligopolistic markets and possess market power. These incumbents' profits are diminished by gazelles' growth. The incumbents may have an incentive to acquire these target firms. In doing so, they can block the growth of gazelles and protect their market share.

The purpose of this paper is to propose a theory of gazelle growth that is consistent with these facts and that is tractable for policy analysis. To this end, we construct a model with the following components. There are three firms in a market. One of them is the market leader, which is labeled the incumbent. Another is a firm that has already been in the market as a competitor to the

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¹ Gazelles and high-growth firms are not necessarily the same. Gazelles are often defined as young firms that are growing rapidly. The definition of high-growth firms, on the other hand, tends to be based on all firms (independent of firm age); see, e.g., Coad, Daunfeldt, Hözl, Johansson, and Nightingale (2014). Our focus here is on gazelles, and a main focus of the analysis is that gazelles need external financing to grow, which is typically the case for young firms.

incumbent; however, its assets are on sale, and it is going out of business. This firm is labeled the target. Finally, the last firm is a new firm entering the market. It is established by an entrepreneur and labeled the gazelle. The incumbent and gazelle are assumed to compete in an oligopolistic fashion. The entrepreneur has invested in an innovative activity that could lead to the creation of a unique business idea or an invention, which could then be used to start a gazelle and make it grow. At the very beginning, the entrepreneur decides whether to invest in the innovative activity. If the entrepreneur is successful in the first period, the gazelle and the incumbent will compete to acquire the target firm's distribution network. If the gazelle does not acquire the target firm's distribution network, the gazelle could grow organically either on a small scale or on a large scale in the second stage. If it grows organically on a small scale, it will face higher distribution costs. The crucial feature of the model is that the gazelle lacks financial resources and needs to borrow when growing by acquisition or engaging in large-scale organic growth. However, the model assumes that the gazelle will not need any external funding for small-scale organic growth.

We first analyze the gazelle growth model. We show that if the gazelle faces sufficiently large distributional costs when investing on a small scale, the incumbent obtains the target firm's distribution network despite the fact that the gazelle would save considerably on the distribution cost by obtaining the target firm's distribution network. Once the distribution cost becomes sufficiently high, this distribution-cost saving effect is dominated by a preemptive anticompetitive effect because, when obtaining the target firm's distribution network in this situation, the incumbent firm gains greater market power in the product market. It faces a competitor (the gazelle) with high distribution costs. Consequently, the incumbent firm obtains the target firm's assets. Therefore, the gazelle is left with the option of growing organically on a low scale. On the other hand, if the gazelle has a better position when growing on a small scale (it becomes a sufficiently large firm by doing so) or if the gazelle can grow on a large scale at a low cost, then the incumbent can no longer prevent the gazelle from enhancing its competitiveness in the product market. Therefore, the incumbent is not willing to pay a high price for the target firm's distribution network.

Access to financing is often difficult for gazelle firms due to their perceived riskiness and lack of collateral. Banks are usually reluctant to lend to gazelles. Therefore, venture capital (VC) is one of gazelles' primary sources of outside equity financing and support. However, the amounts of money that VC firms allocate for different stages of company development vary considerably. In the US, only approximately 4% of all VC deals are made with companies that are in the seed stage, whereas 50% of all deals are made with companies in the early stage.² VC firms prefer to finance early-stage companies that are ready to expand their operations, manufacturing capacities, sales and marketing teams or product development teams. An early-stage gazelle firm that is generating revenue but is not necessarily profitable is not as risky an investment for VC firms as a seed-stage company. Most of the time, gazelle firms have already proven a market need and have already found a good product-market fit. They are ready to increase their market share by enlarging their operations, i.e., acquiring the required assets from another firm for this purpose. Therefore, gazelles are attractive investments for VC firms.

By incorporating VC financing into the model, we show that VC financing indeed leads to higher gazelle growth. Moreover, and perhaps more surprisingly, we show that VC financing increases acquisition growth more than organic growth – by securing VC financing, a gazelle could credibly threaten to invest organically on a large scale if it does not grow by acquisitions. This approach reduces the incumbent's preemptive acquisition motive and decreases the acquisition price for the gazelle when growing by acquisition.

An example of a successful acquisition growth financed by VC is Flipkart, an Indian e-commerce company founded in 2007 by two entrepreneurs. Flipkart experienced high growth by becoming a USD 11 billion market-valued company in February 2016 from a start-up whose equity value was only USD 6000 when it was established. Flipkart managed this rapid growth through several acquisitions financed by VC funds. It was listed number one among the top 10 e-commerce companies in India in terms of funds received. Flipkart obtained USD 542 million by the end of 2014.³ Interestingly, Flipkart's main competitor, Amazon, has tried to buy Flipkart, but instead, Walmart (an outsider to the market) made a staggering offer of USD 16 billion for a controlling stake of 77% in May 2018. An injection of USD 2 billion in fresh investment in Flipkart was also part of the deal.⁴

We next turn to policy issues. Entrepreneurship has emerged as a key issue in the policy arena in Europe and the US. An important factor in the process of commercialization and the growth of small businesses is these firms' access to financing. In addition to bank loan financing, government policies aim at promoting alternative sources of financing, such as public listings for SMEs and venture capital investments. Recently, there has been a substantial increase in spending on such policies. For example, in 2015, the US Small Business Administration (SBA) approved USD 33 billion in loans, and it also provided more than \$6 billion in capital to small businesses through SBICs (Small Business Investment Companies), which are privately owned and managed investment funds that are licensed and regulated by the SBA. These investment funds use their own capital plus funds borrowed with an SBA guarantee to make equity and debt investments in qualifying small businesses.⁵ Another government policy to improve SMEs' access to financing is providing tax exemptions and deferrals, such as the provision of tax incentives for equity investors and businesses. Countries that provided tax subsidies and deferrals targeted at SMEs during the period from 2007 to 2014 included Belgium, Finland, Italy, New Zealand, Norway, Spain, Sweden and Turkey.⁶ We start the policy analysis section by examining the effects of financial support for gazelles. We show that financial support, such as a reduction in the interest rate, tends to improve gazelles' opportunity to grow by acquisition rather than by organic growth because a reduced interest rate improves gazelles' outside option (organic growth), which decreases the

² Source: Yearbook 2016, National Venture Capital Association.

³ Online Source: www.buinessstoday.in, <https://en.wikipedia.org/wiki/Flipkart>, www.indianexpress.com.

⁴ Walmart is buying India's Flipkart, by Rishi Iyengar and Sherisse Pham at CNNMoneyInvest, May 9, 2018, <http://money.cnn.com/2018/05/09/investing/walmart-flipkart-india-softbank/index.html>.

⁵ Source: Summary of Performance and Financial Information Fiscal Year 2015, the U.S. Small Business Administration, 2015.

⁶ Source: Financing SMEs and Entrepreneurs, OECD, 2016.

incumbent's preemptive motive to buy the target, which, in turn, implies that the price of the target firm substantially decreases.

We then show that a subsidy for large-scale organic growth might not increase the incentive for organic growth, which is the objective, but rather may actually decrease it because the subsidy for organic growth reduces the possibility for preemption by the incumbent. The gazelle could credibly threaten the incumbent with large-scale organic growth. A subsidy helps the gazelle decrease the investment cutoff level that determines the profitability and feasibility of large-scale organic growth. In short, by decreasing the investment cutoff level, a subsidy improves the position for the gazelle in the bidding competition against the incumbent while acquiring the target firm.

This paper can be viewed as a contribution to the literature on the growth mode of young, high-growth firms. McCann (1991) notes that young and small firms often do not have sufficient resources to grow aggressively via acquisitions. Several empirical studies provide evidence that organic growth is the dominant mode of growth for young and small firms (e.g., Davidsson & Delmar, 1998; Delmar et al., 2003; Kraemer & Venkataraman, 1997; Levie, 1997). Organic growth is the main mode for non-high-growth firms, while acquisition growth seems more important for high-growth firms (HGFs). Clarysse, Bruneel, and Wright (2011) examine the growth paths of six young technology-based high-growth firms and document that two of them grew mainly via acquisitions. Brown and Mawson (2013) find that HGFs utilize overseas acquisitions to grow more aggressively in their international expansion than non-HGFs. Some firms that grow very quickly and become superstar ventures use acquisitions; e.g., Cisco realized much of its rapid growth via acquisitions (Murmman, Korn, & Worch, 2014). We add to this literature by proposing a model with an endogenous growth mode for young firms. Our model shows that organic growth and acquisition growth are both substitutes and complements for each other. In particular, through this model, we illustrate that if organic growth is very costly, then acquisition growth can be blocked by incumbent firms using preemptive acquisitions.

This paper also contributes to the literature on when entrepreneurs will challenge incumbents or sell their ventures to incumbents. To date, it has been found that a challenge is more likely to happen when entry costs are low, when the entrepreneurial firm has complementary assets, when brokers facilitating trade are not available, when the incumbent's and entrepreneur's assets are substitutes, and when the intensity of product market competition is low (see, for instance, Gans, Hsu, & Stern, 2002; Gans & Stern, 2000; Hellmann, 2002; Henkel, Rønde, & Wagner, 2015; Norbäck & Persson, 2012). We add to this literature by allowing entrepreneurs to challenge leading incumbents not only via organic growth but also through the acquisition of the non-leading incumbent firm's specific assets. This approach enables us to show that a lower cost of organic growth can increase the incentives challenging leading incumbents through acquisition growth. The leading incumbent understands that if it acquired the target firm, the gazelle would then invest organically anyway to grow, and therefore, the acquisition would not be sufficient to protect its market power as a leading incumbent firm from the gazelle. We also show that financial support for the organic growth of gazelles can increase gazelles' growth by acquisitions rather than their organic growth, as incumbents' preemptive motives are reduced.

2. The model

At the outset, an entrepreneur has an idea that has given rise to a viable business model. The entrepreneur will set up a gazelle firm denoted "g", which will bring this novel business model to the market. The gazelle will then compete with an established incumbent firm "i" in an oligopolistic market. There is also a target firm "t" up for sale in the market. The target firm's business is no longer viable due to the emergence of the gazelle, but the target firm owns a distribution network, which may help the gazelle to serve the market. To simplify the analysis, we merely assume that there is a target firm for sale. In a more general setup, we could derive conditions under which the target firm would not be viable and how it would depend on cost asymmetries between the different firms. These cost asymmetries would then stem from different firm-specific assets, such as machinery, patents, management skills, etc.

The interaction between the gazelle and the incumbent occurs in three stages. In the first stage, the target firm sells its assets, denoted k_t . If the gazelle acquires the target firm's assets, it will gain a distribution cost advantage and will be able to distribute its goods (or services) at zero distribution cost, i.e., $d = d_t = 0$; it will also hire L_t^g employees. However, the gazelle lacks financial resources and needs to borrow to be able to pay the acquisition price A . The total acquisition cost is $C_{acq} = A(1 + r)$, where r is the interest rate, i.e., the rate charged by the bank for a loan.

In the second stage, if the gazelle does not acquire the target firm in the first stage, it has the option to grow organically on either a small scale or a large scale. If the gazelle grows organically on a small scale by investing in small-scale assets k_s , it will have a low fixed cost C_s , normalized to zero, but will face a high distribution cost, $d_s > 0$. The gazelle will then hire L_s^g employees. If the gazelle grows organically on a large scale, it will invest in large-scale assets, denoted k_N , at an investment cost of I . This investment, I , will reduce the gazelle's distribution cost to zero, i.e., $d_l = 0$. However, the gazelle needs to borrow to be able to pay the investment cost, I . The total cost of organic growth on a large scale is $C_l = I(1 + r)$. The gazelle will then hire L_l^g employees.

Finally, in the third stage, both the gazelle and the incumbent sell a homogeneous product in the market. The quantities produced and sold by the gazelle and the incumbent are, respectively, q_g and q_i . The gazelle may be exposed to an extra distribution cost d_s , unless it has invested in large-scale assets and has grown organically ($d_l = 0$) or it has acquired the target firm's assets ($d_t = 0$).⁷ It

⁷ The theoretical model presented here builds on Norbäck and Persson (2004, 2005, 2008). It relies on a similar game structure: an acquisition/entry stage using an auction with externalities and an investment stage with an oligopolistic product market stage. The focus of the analysis by Norbäck and Persson (2004, 2005, 2008) is on how the acquisition-greenfield entry pattern of foreign firms depends on trade and greenfield investment costs. In this paper, the model framework is used to determine how the gazelle acquisition vs. organic growth patterns depend on the distribution cost, the interest rate and any subsidy targeted to a gazelle. A policy analysis for gazelle growth is given in a later section.

should be noted that we do not study startups of small firms but rather young firms that may grow to be large firms. Most of these successful growing firms will then compete in situations where they and their rivals have market power, and thus, oligopolistic interaction seems to be a reasonable assumption.

Note that we assume that the incumbent cannot acquire the gazelle, which could be because monopolization of the market would be blocked by antitrust authorities or because the gazelle's business model would not fit into the incumbent's organization, thus rendering the acquisition unprofitable. A third reason would be that other viable incumbents would expand if the incumbent acquired the gazelle, thereby making the acquisition unprofitable.

It should be noted that for some gazelles, bank financing might not be available because their ventures are characterized by high uncertainty. This should be particularly true for high-tech ventures. If other financing, such as venture capital, is not available, the gazelle would not grow. The case in which venture capital is available is examined in Section 4. It is shown that the main analysis carries over to this case as long as the VC firm's injection of capital covers all the investment costs. If so, the main analysis will hold for zero interest ($r = 0$).

2.1. Period 3: the product market

The game is solved via backward induction. In the last stage, the gazelle and the incumbent compete in the product market in a Cournot fashion. The market demand function is given by $P(Q) = a - bQ$ and $a, b > 0$, where $Q = q_g + q_i$.⁸ The incumbent already possesses one unit of distribution assets k_N , but the gazelle initially lacks these assets. Next, depending on which firm acquired the target's assets in period 2, we will have three different ownership structures to consider. To keep track of them, we denote the ownership structure by $M(k_g, L_g, k_i)$, where the gazelle possesses k_g units of assets and L_g numbers of employees and the incumbent possesses k_i units. For example, $M(k_i, L_i, k_N)$ is then the duopoly in which the gazelle owns the target firm's assets k_i and hires L_i employees, whereas the incumbents have their initial assets of k_N , where $k_i = k_N$.

We make some assumptions regarding firms' marginal costs, given different ownerships of the target's assets. A firm possessing at least one unit of large-scale assets is assumed to produce at a zero marginal cost. Thus, the gazelle has a distribution cost disadvantage, d_s , per unit of output while serving the market when it grows organically at a small scale. We assume that the gazelle can avoid this extra cost d_s when it possesses large-scale assets (k_N). Having large-scale assets can be achieved by either acquiring the target firm's assets k_i or growing organically at a large scale k_N . In these two situations, the gazelle will have zero distribution cost as a variable cost, $d = 0$ ($d_i = 0$ or $d_i = 0$).

Let firm j 's profit function be defined by $\pi_j(q_g, q_i) = P(q_g + q_i)q_j - TC_j(q_j)$. Then, $\pi_j^D(d_s)$ indicates the duopoly profit for firm $j = g, i$ when the incumbent firm i has a variable cost of zero ($d_i = 0$) and gazelle firm g has a variable cost of d_s . Moreover, $q_g(d_s)$ denotes the corresponding equilibrium quantity of the gazelle, and $d_s^{\max}$ represents d_s , satisfying $q_g(d_s) = 0$, meaning that the gazelle does not produce or serve the goods in the market due to a high distribution cost. In addition, π^M denotes the monopoly profit when the incumbent firm becomes a monopolist and has zero distribution cost. We can make the following observation:

Observation 1: The incumbent will be hurt by the gazelle's acquisition growth or the gazelle's organic large-scale growth since the incumbent will then face tougher competitors. Thus, the incumbent will have an incentive to prevent the gazelle's expansion.

This preemptive motive is important for the growth pattern of the gazelle, as will be shown below.

2.2. Period 2: organic growth: small scale or large scale?

If the gazelle does not acquire the target firm in the first stage, it may grow organically in the second stage. The gazelle might either undertake large-scale organic growth investment at a cost of $C_i = I(1 + r)$, where I is the original investment cost and r is the interest rate (cost of finance), or grow on a small scale and have a zero fixed cost of $C_s = 0$, but it will have a variable distribution cost greater than zero ($d_s > 0$). In the case of large-scale organic growth, the gazelle reduces its distribution costs from d_s to 0.

The gazelle needs to borrow to be able to invest on a large scale. We define $\bar{I}(d_s, r)$ as the value of the investment cost such that the gazelle firm is indifferent between the alternatives of large-scale and small-scale organic growth. Formally, we find that large-scale organic growth occurs when the following holds: $\bar{I}(d_s, r) = \frac{\pi_g^D(0) - \pi_g^D(d_s)}{1 + r}$ if $d_s < d_s^{\max}$, and $\bar{I}(d_s, r) = \frac{\pi_g^D(0)}{1 + r}$ otherwise. In the above expression, $\pi_g^D(0)$ stands for the gazelle's profit when it has a zero distribution cost, and $\pi_g^D(d_s)$ stands for the gazelle's profit when it has a distribution cost $d_s > 0$.

Because the gazelle's small-scale growth profits $\pi_g^D(d_s)$ decrease monotonically in d_s , the critical investment cost $\bar{I}(d_s, r)$ is increasing in d_s and reaches its maximum at the point at which $d = d_s = d_s^{\max}$. When $d_s > d_s^{\max}$, the gazelle does not produce and sell the good unless it invests organically in large-scale assets with a critical investment cost of $\bar{I}(d_s, r) = \frac{\pi_g^D(0)}{1 + r}$, where $\pi_g^D(0) = C_i = I(1 + r)$.

We can make the following observation:

Observation 2: If the cost of financing r is too high, large-scale organic growth will not be profitable for the gazelle.

⁸ We assume that firms have a strictly concave inverse demand function, such that $P'(Q) < 0$ and $P''(Q) < 0$.

Whether the gazelle will have an incentive for large-scale organic growth is an important factor in determining the outcome of the bidding competition over the target firm acquisition, as will be explained below.

2.3. Period 1: the acquisition game

The acquisition process is depicted as a perfect-information auction in which the two firms simultaneously post bids, and the bidder with the highest bid obtains the target firm.^{9,10} To solve the acquisition auction and determine bids, we need to determine the valuations of the bidders for obtaining the target firm's assets. To aid in this process, we introduce the net gain function $N_g(A)$, which defines the net gain for the gazelle if the acquisition price is A . Furthermore, we assume that the acquiring firm borrows to be able to pay the acquisition price and has to pay an interest rate r .

A gazelle will have net gain functions defined as follows:

$$N_g(A) = \underbrace{[\pi_g^D(0) - (1+r)A]}_{\text{Acquire}} \underbrace{[\pi_g^D(0) - (1+r)I]}_{\text{Do not acquire}}, \quad \text{if } I < \bar{I}(d_s, r) \quad (1)$$

$$N_g(A) = \underbrace{[\pi_g^D(0) - (1+r)A]}_{\text{Acquire}} - \underbrace{[\pi_g^D(d_s)]}_{\text{Do not acquire}}, \quad \text{if } I > \bar{I}(d_s, r). \quad (2)$$

Let us start with the first line, where the alternative to the acquisition for the gazelle is large-scale organic growth. The first term consists of product market profits net of the acquisition price, including interest payments $\pi_g^D(0) - (1+r)A$. The second term is the product market profits in the case in which the gazelle does not acquire the target firm and instead grows organically on a large scale, net of the investment cost including interest payments $\pi_g^D(0) - (1+r)I$.

We should note that a key insight is that a gazelle's maximum willingness to pay (v_g) for the target firm depends on what happens if it does not acquire the target firm, i.e., it might then invest organically on a large scale or not. The second line describes the valuations when the gazelle instead undergoes small-scale organic growth.

For the gazelle, the maximum willingness to pay, v_g , can be determined to be $v_g = \min A$, s. t. $N_g(A) \geq 0$, where A is the acquisition price. Solving for $N_g(A) = 0$, we obtain the maximum willingness to pay for each of the two net gain functions as follows:

$$v_g = I \text{ if } I < \bar{I}(d_s, r) \quad (3)$$

$$v_g = \frac{\pi_g^D(0) - \pi_g^D(d_s)}{1+r} \text{ if } I > \bar{I}(d_s, r). \quad (4)$$

Let us now turn to the incumbent's valuation of the target firm's assets. The maximum willingness to pay for the incumbent, v_i , to acquire the target firm can be directly written as

$$v_i = 0 \quad \text{if } I < \bar{I}(d_s, r) \quad (5)$$

$$v_i = \pi_i^D(d_s) - \pi_i^D(0) \quad \text{if } I > \bar{I}(d_s, r) \quad \text{and } d_s < d^{\max} \quad (6)$$

$$v_i = \pi_i^M - \pi_i^D(0) \quad \text{if } I > \bar{I}(d_s, r) \quad \text{and } d_s > d^{\max} \quad (7)$$

We note that the game is solved with the backward induction method. We look for a subgame perfect equilibrium. Let us begin with Eq. (5) where the alternative to the acquisition of the incumbent itself is the large-scale organic growth of the gazelle firm. Then, the incumbent obtains no value from buying the target firm's assets. Its willingness to pay for the acquisition will be zero, $v_i = 0$. The reason is that the intensity of competition is not affected by the incumbent's acquisition of the target firm, and no cost savings occur when $I < \bar{I}(d_s, r)$.

However, Eq. (6) shows that when the alternative to the acquisition of the target firm by the incumbent is the small-scale organic growth of the gazelle, the acquisition by the incumbent will have an effect on the competition in the product market. The incumbent will then ensure that it will face a weaker rival if it acquires the target firm's assets. This is captured by the term $\pi_i^D(d_s) - \pi_i^D(0) > 0 \Rightarrow v_i > 0$. The marginal willingness to pay in the acquisition will be greater than zero for the incumbent.

Finally, Eq. (7) captures the case when the acquisition by the incumbent completely blocks the expansion of the gazelle firm and the incumbent becomes a monopolist. In this case, large-scale organic growth is not feasible for the gazelle due to the high investment cost and production on a small scale is not feasible for the gazelle due to the high distribution cost.

The analysis is straightforward because both firms will bid their maximum willingness to pay, and we can state the following

⁹ Thus, we abstract from asymmetric information problems to focus on the competitive effects of the acquisition.

¹⁰ If more than one firm posts such a bid, each firm obtains the assets with equal probability. The winning buyer pays an amount equal to his bid. The auction will be solved for Nash equilibria in undominated pure strategies. There is assumed to be the smallest monetary unit, denoted ε . We assume that ties will be randomly broken and all equalities in valuations will be ruled out. The smallest amount ε is chosen such that all inequalities are preserved if ε is added or subtracted.

result:

Lemma 1. Let firm i be the firm with the highest valuation, v_i . The target firm's assets are then acquired by firm i at a price equal to the other firm's valuation: firm h 's valuation of obtaining the target firm's assets instead of the firm i itself, v_h .

3. The gazelle growth pattern

One more definition is required to proceed. To this end, we consider the situation where no large-scale organic growth investment takes place. The only way for the gazelle to decrease the distribution cost to zero, $d = 0$, is an acquisition. We make use of the following definition:

Definition 2. Preemption condition: As v_g is the maximum willingness to pay for the gazelle to acquire the target firm and v_i is the maximum willingness to pay for the incumbent firm, let d_s^* be the value of the distribution cost satisfying the following equality when $I > \bar{I}(d_s, r)$: $v_g = \frac{\pi_i^D(0) - \pi_i^D(d_s^*)}{1+r} = \pi_i^D(d_s^*) - \pi_i^D(0) = v_i$.

Therefore, d_s^* is the distribution cost at which the gazelle and the incumbent firms' valuations of the target firm's assets coincide, given that no large-scale organic growth investment takes place. We are now set to derive the equilibrium ownership structure in the gazelle growth model presented above.

The game is solved backwards, and the following proposition identifies the equilibrium ownership structure and the equilibrium auction price.

Proposition 3. The equilibrium ownership structure and the gazelle growth pattern are as follows:

- (ii) If $I > \bar{I}(d_s, r)$ and $d_s < d_s^*$, the gazelle grows by acquisition. It obtains the target firm's assets at a price of $A = v_i = \pi_i^D(d_s) - \pi_i^D(0)$. The ownership structure is $M(k_i, L_i^g, k_N)$, where the gazelle owns the asset of the target firm, k_i .
- (iii) If $I < \bar{I}(d_s, r)$, the gazelle grows by acquisition. It obtains the target firm's assets at a price $A = v_i = 0$. The ownership structure is $M(k_i, L_i^g, k_N)$, where the gazelle owns the assets of the target firm, k_i .

Proof. See the Appendix. To understand the logic of Proposition 3, we should note that firms' valuations depend on the gazelle's decision in stage 2, i.e., whether it makes investments and grows organically on a large scale. In the following subsections, we will examine the two separate cases more closely.

High cost of large-scale organic growth, i.e., $I > \bar{I}(d_s, r)$: Let us now characterize the difference between the valuations of the incumbent and the gazelle, $v_i - v_g$; when the gazelle will not grow on a large scale organically in stage 2, if it loses the auction in stage 1. This is the case when the investment cost is too high, i.e., $I > \bar{I}(d, r)$.

In this case, $v_i - v_g = \pi_i^D(d) - \pi_i^D(0) - \left(\frac{\pi_i^D(0) - \pi_i^D(d)}{1+r} \right)$. It follows directly that $v_i - v_g = 0$ when $d = 0$, i.e., the value of avoiding high distribution costs equals the value of preemption. Let us now analyze how an increase in d affects the difference in valuations. At first glance, one might believe that an increase in d would make the value of avoiding the distribution cost, v_g , increase more than the value of preemption (the value of decreasing competition through target firm acquisition by the incumbent), v_i , because the gazelle has an incentive to avoid these higher distribution costs. However, more effects are involved. Following Norbäck and Persson (2004), we differentiate $v_i - v_g$ with respect to d and use the FOC's yields:¹¹

$$\frac{d(v_i - v_g)}{dd} = \frac{dQ(d)}{dd} P'q_i(d) + \frac{dq_i(d)}{dd} d - q_g(d). \quad (8)$$

The first term in Eq. (8) captures the *anticompetitive effect* because the increased distribution cost induces the gazelle to be less aggressive in its market interaction, which softens competition and increases revenues for the incumbent. The second term reflects the decrease in total distribution costs as the incumbent firm steals business from the gazelle. This effect is referred to as the *business-stealing effect*. The first two terms in Eq. (8) increase the incumbent firm's valuation of the target firm's assets relative to that of the gazelle firm. The third term, the *direct distribution cost effect*, decreases the incumbent firm's valuation relative to that of the gazelle, as the gazelle firm faces higher distribution costs.

Let us now analyze how the difference in valuations $v_i - v_g$ depends on d . At $d = 0$, the *distribution cost effect* dominates the *anticompetitive effect*. At higher distribution costs, however, the direct distribution cost effect is weaker because the gazelle's sales are smaller. However, both the anticompetitive and the business-stealing effects are stronger because the incumbent has a larger market share, and each unit shifted from the gazelle to the incumbent implies greater cost savings. Hence, once the distribution costs become sufficiently high, $v_i - v_g$ will rise. When the distribution costs become sufficiently high at $d = d^{\max}$, the incumbent becomes a monopolist, and consequently, v_i is then greater than v_g .

In summary, when the distribution costs are high, the incumbent firm can prevent the gazelle from becoming a tough competitor, and thus, its willingness to pay for the target firm's assets increases. The preemptive value increases. Consequently, the acquisition by the incumbent is more likely to happen.

¹¹ Please refer to Appendix A.3 for the derivation of Eq. (8).

Low cost of large-scale organic growth, i.e., $I < \bar{I}(d_s, r)$: In this case, the gazelle will grow organically on a large scale in stage 2 upon losing the auction in stage 1 because the investment cost is sufficiently low, i.e., $I < \bar{I}(d, r)$. If the incumbent acquires the target firm's assets, the gazelle organically invests on a large scale, and no firm faces any distribution costs in the product market, but the gazelle faces an investment cost, I . If the gazelle acquires the target firm's assets, the investment cost is avoided. Consequently, since $v_g - v_i = I$ and $I > 0$, it follows that $v_g > v_i$.

Intuitively, the lower cost of large-scale organic growth decreases the incumbent firm's willingness to pay because the gazelle can credibly threaten to grow organically on a large scale if it does not obtain the target firm's assets. This situation implies that the value of preemption disappears. At the same time, the gazelle is still willing to pay I for the target firm's assets.

The above analysis thus contains several noteworthy features.

Observation 3: When the cost of large-scale organic growth is high and the distributional costs are high for small-scale entry, the incumbent firm obtains the target firm's assets despite the fact that the gazelle would save considerably on the distribution cost by obtaining the target firm; when obtaining the target firm's assets, the incumbent firm gains high market power in the product market because it then faces a competitor with high distribution costs.

Observation 4: When the cost of growing organically on a large scale is sufficiently low, the gazelle grows by acquisition and obtains the target firm's assets because the strategic position in the bidding competition in acquiring the target firm is improved for the gazelle since it can credibly threaten to invest organically on a large scale if it does not acquire the target firm.

4. Venture capital

Empirical studies show that venture capitalists mostly concentrate their investment in early-stage entrepreneurial firms that have the potential to grow quickly. For instance, from data on 794 capital-backed ventures, Gompers (1995) finds that VC firms invest their funds mostly in high-technology startup companies, where the informational asymmetries are highest. Gompers also concludes from his data that the duration of VC financing is related to the nature of invested firms' assets: higher industry ratios of tangible assets to total assets, lower market-to-book ratios, and lower R&D intensities are associated with VC firms' longer funding duration. Therefore, as we see in the real-life business case of Flipkart, quickly growing start-ups are more likely to attract more VC funding over longer periods to finance their growth by acquisitions because they increase their tangible assets by acquiring other firms. When there is a specific asset to be acquired, venture capitalists are more eager to deal with information asymmetries in gazelles that naturally exist.

By providing capital funds to entrepreneurial firms, VC firms infuse financial strength and competence into ventures. Furthermore, VC firms improve the overall efficiency of entrepreneurial firms by helping them decrease their production costs and/or increase their sales (Chemmanur, Krishnan, & Nandy, 2011). Next, we focus on how increased financial strength affects the growth pattern of a type of entrepreneurial firm: gazelles.

Let us now incorporate VC financing into our model. Once an entrepreneurial firm makes a deal with a VC firm, it will obtain additional equity in cash, F . This VC fund F can be used partly or totally to finance the acquisition or large-scale organic growth. We assume that two symmetric VC firms compete to invest in the gazelle. We also assume that the VC firms are perfectly informed about the future profitability of the gazelle. Moreover, the gazelle is indifferent between these two symmetric VC firms. We also simplify the analysis by assuming that the gazelle needs a fixed amount of capital, F .

In equilibrium, one of these VC firms invests F amounts of funds in the gazelle and obtains an amount of shares valuing the equivalent of the amount F of the gazelle's ownership. This process follows from the fact that the VC firms compete and make zero profit on their investments. Therefore, the investor VC firm will receive $\frac{F}{TSHE}$ amounts of shares in the gazelle's ownership, where $TSHE$ stands for the gazelle's total shareholder equity after the injection of VC equity. $TSHE$ is the net present value of the gazelle's future product market profits, net of investment costs.

We do not focus on any other detailed conditions, such as dividend policy, management, exit of the VC firm, etc., of the contract between the VC firm and the gazelle. We suppose that the level of VC ownership in the gazelle will not affect the gazelle's objective function. The gazelle will always maximize its profits.

We will now examine how the infusion of capital will affect the gazelle's growth pattern. In our analysis, we once more distinguish between the cases when large-scale organic growth is feasible and when it is not feasible.

High cost of large-scale organic growth, i.e., $I > \bar{I}(d_s, r)$: Here, we assume that if the gazelle did not acquire the target in the auction in stage 1, it would not grow organically on a large scale in stage 2. From Lemma 1, it follows that a gazelle acquisition takes place if and only if $v_i - v_g < 0$.

Our analysis now concentrates on how the valuations of the target firm for the incumbent and the gazelle are affected by the introduction of VC financing. First, note that the incumbent's valuation is not affected and is still given by expressions (6) and (7). However, the gazelle's valuation will change. To observe this change, we rewrite the gazelle net gain function as follows:

$$N_g(A) = \underbrace{[\pi_g^D(0) - (1+r)(A-F)]}_{\text{Acquire}} - \underbrace{[\pi_g^D(d_s) + F]}_{\text{Do not acquire}}, \text{ if } I > \bar{I} \left(d_s, r \right). \quad (9)$$

The VC firm's infusion of capital reduces the acquisition cost, as captured by the term $(1+r)(A-F)$. Moreover, in the case of no expansion, the infusion of capital will come up as an additional capital F , where it is assumed that there is no interest in this capital.¹² Solving for $N_g(A) = 0$, we obtain the maximum willingness to pay for the gazelle:

$$v_g = \frac{\pi_g^D(0) - \pi_g^D(d_s) + rF}{1+r} \quad \text{if } I > \bar{I}(d_s, r). \quad (10)$$

As a result, the gazelle's valuation v_g will increase by the amount of $\frac{rF}{1+r}$, which captures the saved interest rate expense associated with the acquisition. Therefore, the difference between the maximum willingness to pay of the incumbent and the entrepreneurial firm, $v_I - v_g$, decreases when the entrepreneurial firm receives venture capital equity, F .

Low cost of large-scale organic growth, i.e., $I < \bar{I}(d_s, r)$: We examine the case in which $I < \bar{I}(d_s, r)$. The entrepreneurial firm can credibly threaten the incumbent with large-scale organic growth, and the value of preemption for the incumbent will be zero. Moreover, the gazelle's valuation will not change. After obtaining VC funds F , the gazelle has a net gain function defined as follows:

$$N_g(A) = \underbrace{[\pi_g^D(0) - (1+r)(A-F)]}_{\text{Acquire}} - \underbrace{[\pi_g^D(0) - (1+r)(I-F)]}_{\text{Do not acquire}}, \quad \text{if } I < \bar{I}(d_s, r). \quad (11)$$

Solving for $N_g(A) = 0$, we obtain

$$v_g = I \quad \text{if } I < \bar{I}(d_s, r). \quad (12)$$

Capital infusion can be used to finance either acquisitions or large-scale organic growth; the tradeoff between acquisitions and large-scale growth is not affected.

How is the large-scale organic growth cutoff investment amount, $\bar{I}(d_s, r)$, affected by a capital injection from the VC firm? We evaluate how the incentive to undertake a large-scale organic growth changes after a VC equity injection into the gazelle, given that the gazelle does not acquire the target firm in the first period. Formally, we state that

$$\begin{aligned} \bar{I}(d_s, r) &= \frac{\pi_g^D(0) - \pi_g^D(d_s) + rF}{1+r} \quad \text{if } d_s < d_s^{\max} \quad \text{and} \\ \bar{I}(d_s, r) &= \frac{\pi_g^D(0) + rF}{1+r} \quad \text{otherwise.} \end{aligned}$$

As can be observed from the above formulas, there is a positive relationship between the cutoff investment level and the VC funding. The higher the VC financing is, the higher $\bar{I}(d_s, r)$ because the gazelle is willing to pay more for large-scale organic growth investment since the cost of financing is lower.

$$\frac{d\bar{I}(d_s, r)}{dF} = \frac{r}{1+r} > 0$$

Therefore, the infusion of the VC fund makes investment in large-scale organic growth more feasible and thus the gazelle's threat more credible since the interest cost of financing large-scale organic growth can be reduced by the amount rF .

To summarize, we can state the following results:

Proposition 4. A gazelle that receives VC funding is more likely to grow by acquisition for the following reasons:

- (ii) The cutoff investment cost of large-scale organic growth for the gazelle increases due to decreased interest payments in financing the investment. This phenomenon improves the gazelle's strategic position and reduces the incumbent's preemptive acquisition motive.

As a final remark, it can also be argued that increasing the level of equity in the gazelle's balance sheet will ease the bargaining conditions of the entrepreneurial firm with banks or other types of debtors. In the case where the VC fund cannot finance the acquisition alone or the acquisition is partly financed via VC equity and partly via bank borrowing, the cost of debt, r , may decrease for the gazelle. Having a higher amount of equity and thus a lower leverage ratio will allow the gazelle to face a lower rate of interest when bargaining with debtors. This situation will further strengthen the results derived above.

In practice, the VC also provides assets other than financial assets to the venture, such as knowledge and network assets. Unless these assets are much more useful for organic growth than for acquisition growth, our results will hold. Extending the analysis, allowing for different types of investors with different assets and examining how this will affect the growth pattern seem to be interesting avenues for future research.

Additionally, note that if organic growth can only occur slowly because the needed resources are provided step-by-step by the

¹² This assumption is crucial. When allowing the gazelle to earn the same interest in its bank account as the bank requires for lending, venture capital would have no effect on the valuation.

venture capitalist, an incumbent acquisition may substantially slow the market penetration of the gazelle. Hence, even if venture capital is available, the incumbent may still have a strong incentive to acquire the target.

5. Policy

Policymakers are concerned with gazelle development and growth; they would like to find an efficient means for gazelle development. The endogenous nature of the buyer's identity, the competition from the incumbent and the determination of the auction price in the present analysis, in addition to the different types of growth strategies available for the gazelle, all imply that the optimal policy is very complicated. Therefore, we will make a couple of remarks about policy. These remarks seem to open an interesting avenue of future investigations.

5.1. Reduction in the interest rate

One of the most discussed means of supporting gazelles is to provide them with financial resources under better financial conditions. To capture this phenomenon in our model, we examine how a reduction in the interest rate, r , affects the equilibrium market structure and the gazelle growth pattern.

High cost of large-scale organic growth, i.e., $I > \bar{I}(d_s, r)$: Given that large-scale organic growth is not feasible, i.e., $I > \bar{I}(d_s, r)$, it follows that when r decreases, an acquisition by the gazelle becomes more likely. To analyze this possibility, remember that according to Lemma 1, an acquisition by the gazelle takes place if and only if $v_i - v_g < 0$. In this expression, the incumbent's marginal willingness to pay, $v_i = \pi_i^D(d_s) - \pi_i^D(0)$, is independent of r . On the other hand, we show that the gazelle's marginal willingness to pay, $v_g = \frac{\pi_g^D(0) - \pi_g^D(d_s)}{1+r}$, decreases in r since

$$\frac{dv_g}{dr} = -\frac{\pi_g^D(0) - \pi_g^D(d_s)}{(1+r)^2} < 0$$

As a result, by reducing the interest rate, the government lessens the acquisition cost of the gazelle and thus increases the gazelle's marginal willingness to pay, v_g . As a result, a reduction in the interest rate makes an acquisition more likely for the gazelle.

Low cost of large-scale organic growth, i.e., $I < \bar{I}(d_s, r)$: We now analyze the situation after the reduction in the interest rate when $I < \bar{I}(d_s, r)$. The entrepreneurial firm can credibly threaten the incumbent with large-scale organic growth. Then, the value of preemption for the incumbent will be zero, as expected. Moreover, the gazelle's valuation will not change after the decrease in the interest rate. The gazelle has a net gain function defined as follows:

$$N_g(A) = \underbrace{[\pi_g^D(0) - (1+r)A]}_{\text{Acquire}} - \underbrace{[\pi_g^D(0) - (1+r)I]}_{\text{Do not acquire}}, \text{ if } I < \bar{I}(d_s, r). \quad (13)$$

Solving for $N_g(A) = 0$, we obtain

$$v_g = I \text{ if } I < \bar{I}(d_s, r). \quad (14)$$

As can be observed from the above, the gazelle's marginal willingness to pay in an acquisition is independent of the interest rate when large-scale organic growth is already feasible. Because the gazelle can benefit from a lower interest rate in both financing an acquisition and making an investment in large-scale organic growth, the tradeoff between an acquisition and large-scale growth is not influenced by a reduction in the interest rate.

How is the large-scale organic growth cutoff investment amount, $\bar{I}(d_s, r)$, influenced by a lower interest rate? Given that the gazelle does not acquire the target firm in the auction, we analyze how its incentive to make a large-scale organic growth investment will be influenced by a drop in the interest rate. The large-scale organic growth investment cutoff level, $\bar{I}(d_s, r)$, will increase as the interest rate r drops. The lower the interest rate is, the higher $\bar{I}(d_s, r)$ because a decreasing interest rate makes the gazelle more willing to make an investment in large-scale organic growth. The financial capacity of the gazelle improves. We can view the negative relation between the cutoff investment level for large-scale organic growth, $\bar{I}(d_s, r) = \frac{\pi_g^D(0) - \pi_g^D(d_s)}{1+r}$, and the interest rate, r , as follows:

$$\bar{I}(d_s, r) = \frac{\pi_g^D(0) - \pi_g^D(d_s)}{1+r}$$

$$\frac{\partial \bar{I}(d_s, r)}{\partial r} = \left[\pi_g^D(0) - \pi_g^D(d_s) \right] \left[-1 \right] (1+r)^{-2}$$

Then, we evaluate the sign of the derivative of $\bar{I}$ with respect to r calculated above,

$$\frac{\partial \bar{I}(d_s, r)}{\partial r} = \frac{-[\pi_g^D(0) - \pi_g^D(d_s)]}{(1+r)^2} < 0$$

$$\frac{d\bar{I}(d_s, r)}{dr} < 0 \text{ since we know that } \pi_g^D(0) > \pi_g^D(d_s).$$

Increasing financial capacity due to the drop in the interest rate makes the gazelle more likely to undergo large-scale organic growth. However, this also means that the gazelle can credibly threaten the incumbent with a more probable large-scale organic growth scenario and can decrease the incumbent's preemptive motive for acquisition in the first stage.

Furthermore, when the interest rate drops, the financial capacity of the gazelle increases for both large-scale organic growth and acquisitions. However, due to competition, the gazelle is more willing to make an acquisition in the first stage than a large-scale investment in the second stage. Therefore, the gazelle will save time in competition since making a large-scale investment one period later and an investment (e.g., constructing a warehouse from scratch) will take some time. In the first stage, with the drop in the interest rate, the gazelle's willingness to acquire increases more than that of the incumbent because the incumbent does not need to borrow under any circumstances. This situation implies that an acquisition by the gazelle becomes more likely when the interest rate in the economy decreases because the gazelle can also obtain the target firm's assets at a lower borrowing cost. As an interesting result, better financial conditions for organic growth can actually reduce organic growth and can instead increase acquisition growth.

Proposition 5. A gazelle that receives better financial conditions (lower interest rates r) is more likely to grow through acquisitions for the following reasons:

- (i) A decrease in the interest rate will motivate the gazelle to acquire the target firm by increasing the gazelle's marginal willingness to pay: $\frac{dv_g}{dr} < 0$.
- (ii) A decrease in the interest rate will make the gazelle's acquisition more likely because the gazelle will have a greater opportunity to undergo large-scale organic growth in the second stage due to $\frac{d\bar{I}(d_s, r)}{dr} < 0$. This situation enables the gazelle to pose a credible threat to the incumbent in the first stage. The incumbent's preemptive motive decreases with a credible threat.

5.2. Subsidy for organic growth

Another means of providing financial support to gazelles is directly subsidizing the organic growth of these firms. In the US, for example, one of the main programs to promote small businesses is the Technological Innovation Program (TIP), which subsidizes the commercialization of successful prototypes with up to USD 3 million. This support scheme is available only if the SME markets the product itself or is the leading company in a joint venture (OECD, 2010, p. 106). See OECD (2010) for a listing of similar support schemes for SMEs in all OECD member states. To analyze the effects of a subsidy targeted to gazelles in our model, we examine how a subsidy of S targeted at large-scale organic growth affects the equilibrium market structure and the gazelle growth pattern. In our analysis of the effect of a subsidy on the gazelle's growth pattern, we again distinguish between the case in which large-scale organic growth is feasible and the case in which it is not feasible.

High cost of large-scale organic growth, i.e., $I > \bar{I}(d_s, r)$: Here, we assume that if the gazelle were not to acquire the target firm in the auction in stage 1, it would not grow organically on a large scale in stage 2. From Lemma 1, it follows that a gazelle acquisition occurs if and only if $v_i - v_g < 0$. Because the subsidy of S affects neither v_i nor v_g , the support for organic growth, a subsidy, has no impact on the growth pattern of the gazelle when large-scale organic growth has already become infeasible.

Low cost of large-scale organic growth, i.e., $I < \bar{I}(d_s, r)$: Let us now examine the case in which $I < \bar{I}(d_s, r)$, i.e., large-scale organic growth is feasible. The gazelle firm can credibly threaten the incumbent with large-scale organic growth, and the value of preemption for the incumbent will be zero. However, the gazelle's valuation will change, as can be observed from the gazelle's net gain function:

$$N_g(A) = \underbrace{[\pi_g^D(0) - (1+r)A]}_{\text{Acquire}} - \underbrace{[\pi_g^D(0) - (1+r)(I-S)]}_{\text{Do not acquire}}, \text{ if } I < \bar{I}(d_s, r) \quad (15)$$

Solving for $N_g(A) = 0$, we obtain

$$v_g = I - S \text{ if } I < \bar{I}(d_s, r). \quad (16)$$

Because the subsidy S can only be used to save the financing cost of organic growth, the tradeoff between an acquisition and large-scale organic growth is affected. The gazelle will acquire the target firm. However, this result is valid as long as $I > S$.

How is the large-scale organic growth investment cutoff level, $\bar{I}(d_s, r)$, affected by a subsidy targeted at organic growth? Let us analyze how the incentive to undertake large-scale organic growth changes once a subsidy is given under the condition that the gazelle did not acquire the target firm in the first stage. When the gazelle is provided with a subsidy, an investment in large-scale organic growth will be more affordable for the gazelle. Formally, we know that after a subsidy, large-scale organic growth occurs when

$$\bar{I}(d_s, r) = \frac{\pi_g^D(0) - \pi_g^D(d_s) + rS}{1+r} \text{ if } d_s < d_s^{\max} \text{ and}$$

$$\bar{I}(d_s, r) = \frac{\pi_g^D(0) + rS}{1+r} \text{ otherwise.}$$

The gazelle will save some interest payment at the amount of rS by borrowing less from the debtors by the amount of S . The gazelle's financial capacity for large-scale organic growth improves after receiving a subsidy from the government. Therefore, $\bar{I}(d_s, r)$ increases due to the subsidy given to the gazelle:

$$\frac{\partial \bar{I}(d_s, r)}{\partial S} = \frac{r}{1+r} > 0 \text{ since } r > 0.$$

Because the subsidy gives a greater opportunity for large-scale organic growth to the gazelle, the gazelle could more credibly threaten the incumbent. Therefore, in the first stage, the incumbent will not be interested in acquiring the target firm, and the value of the preemption move will disappear.

In conclusion, a subsidy for large-scale organic growth implies that large-scale organic growth becomes profitable for the gazelle when it has not obtained the target firm's assets. This, in turn, implies that an acquisition by the gazelle could become more likely since the gazelle could then credibly "threaten" the incumbent in the first stage to grow organically on a large scale in the second stage if it does not obtain the target firm's assets. As an interesting result, subsidies targeted to increase gazelles' organic growth can actually reduce their likelihood of organic growth and instead increase their likelihood of acquisition growth.

Proposition 6. A subsidy targeted to increase the gazelle's organic growth can, in fact, lead to an increase in the acquisition growth:

(i) A subsidy, S , will make large-scale organic growth more likely for the gazelle in the second stage due to $\frac{\partial \bar{I}(d_s, r)}{\partial S} > 0$, and therefore, the gazelle will pose a more credible threat to the incumbent in the first stage. The incumbent's preemptive motive will decrease.

One might argue that the key to an efficient gazelle subsidy policy is to target these to specific firms. However, gazelles' growth rates tend to be very erratic, i.e., these firms are essentially 'one-hit wonders', unable to repeat their high growth rates.¹³ This phenomenon implies that targeting policies to specific firms seems difficult in practice.

6. Extension

6.1. Labor market effects

The effects of gazelle growth on the demand for labor will depend on several characteristics of gazelle growth. First, they will depend on whether the gazelle's labor investment is a substitute or a complement to its capital investment. For instance, if the capital investment requires that many computer programmers or sales personnel need to be hired, then capital and labor are complements. In this case, L_i^g will be large and employment will increase. However, if the capital investment is in machinery and it replaces low-skilled employees, then capital and labor are substitutes. In this case, L_i^g will be small and employment will decrease.

Second, the effects will depend on whether the gazelle growth mostly replaces the incumbent's sale or if it creates new demand. If gazelle growth creates new demand, then aggregate demand for labor will be high, and L_i^g will be large.

Third, the effects will depend on the type of acquisition growth of the gazelle. If the acquisition is mostly associated with using existing capital from the acquired firm and reducing existing employees, then employment will decrease, i.e., L_i^g will be small. However, if there are complementary labor and capital investments associated with the gazelle's acquisition, employee hiring might actually increase, i.e., L_i^g will be large.

6.2. The incumbent's incentive and opportunity to acquire the gazelle

What would be the effects of allowing the incumbent to acquire the gazelle? Such an acquisition would give rise to a stronger market power effect than the acquisition of the target firm, which implies that an acquisition of the gazelle by the incumbent might be the outcome of the game if such an alternative were incorporated into the model. However, there are a couple of reasons why an acquisition of the gazelle by the incumbent may not occur. First, in most jurisdictions, a merger that concentrates the market too much will not be allowed. In fact, it seems as this phenomenon could explain why Amazon could not acquire Flipkart in the example mentioned in the introduction.¹⁴ Second, when more than one incumbent acquires the gazelle, an acquisition might benefit the non-acquiring incumbents most because they will expand their business following the merger (Norback & Persson, 2012). Additionally, this aspect seems to be consistent with our example of Flipkart, in which Walmart (an outsider to the e-commerce market) was able to outbid Amazon (an incumbent) and where a large third player (Snapdeal) was present in the market. Thus, our identified mechanism seems to also be at play when the possibility of acquiring the gazelle was included in the model. However, an interesting avenue for future research would be to extend the analysis to the case in which the possibility of acquiring the gazelle is included in the model, to analyze how the incentives to start a gazelle firm are affected by this possibility and to study the timing of such acquisitions.

¹³ See, for instance, Daunfeldt and Halvarsson (2015), Hölzl (2014), Parker, Storey, and van Witteloostuijn (2010).

¹⁴ An acquisition of Flipkart by Amazon would likely have been scrutinized by the Competition Commission of India (CCI), given the dominant market share these two entities have in the e-commerce space—approximately 70 percent collectively (see Flipkart likely to go with Walmart even as Amazon makes a last-ditch bid: report BusinessToday, May 3, 2018, www.businesstoday.in/current/corporate/flipkart-walmart-amazon-acquire-buy-deal-stake-softbank/story/276148.html).

7. Conclusion

Gazelles can either grow organically by establishing a new facility or acquiring a suitable target firm to grow. We show that the lower cost of organic growth can increase the incentives for acquisition growth. This result seems counterintuitive at first sight but makes sense as soon as one takes into account how the acquisition price of a target firm is determined. When the cost of organic growth is high for the gazelle, the incumbent will benefit considerably from acquiring the target firm because the incumbent will thereby protect its market power in the product market. When the cost of organic growth drops, the incumbent takes into account that if it acquires the target firm, the gazelle will invest organically in order to grow, and therefore, the acquisition will not be sufficient to protect the incumbent's market power. The gazelle can acquire the target firm at a good price and will prefer acquisition growth to organic growth.

One of the major obstacles to gazelle growth is the cost of financing. Receiving equity from a venture capital firm will reduce the gazelle's financing burden for growth. The financial strength gained from the venture capital funds will reduce the incumbent's opportunity and motivation to impede the gazelle's growth by making the acquisition itself. Therefore, venture capital support will induce the gazelle's acquisition.

These results suggest that financial policies supporting the growth of gazelles may, in particular, ignite gazelle growth through acquisitions because these policies not only reduce the financial cost for the gazelles but also reduce the possibility for incumbents to use strategic gazelle growth acquisitions. Policies improving both the financial market for gazelles and the M&A market could then substantially spur gazelle growth. In contrast, the existing policies do, to a large extent, exclusively focus on stimulating the organic growth of small firms, and there is a lack of policies that stimulate ownership transfers.

Policymakers are interested in promoting gazelle development since gazelles create many jobs through organic growth. However, if gazelles grow via acquisition, it is possible that no new jobs are directly created, so policymakers might be less interested in promoting the growth of gazelles via acquisition. In contrast, if there are complementary labor investments associated with the gazelle's acquisition, the hiring of new employees might actually increase. In fact, using panel data on Swedish firms over a 10-year period, Lockett, Davidsson, Wiklund, and Girma (2011) find that previous acquisition growth has a positive effect on current organic growth, which will in turn increase new employment in the future. Thus, policymakers might consider the possibility that acquisition and organic growth by gazelle firms are complements.

The model has several limitations. The first limitation is that there is only one incumbent, one gazelle, and one asset that belongs a target firm and is up for acquisition. If we were to add multiples of any of these three categories, the model would be more complicated. However, the key assumption is that there are sufficiently few of these categories to have the mechanisms identified here in play. If there were many assets (target firms) to acquire, the incumbent would not be able to easily pre-empt the gazelle; if there were many gazelles, the incumbent presumably would not be able to pre-empt them all; and if there were many incumbents, the strategic motive to acquire would be much lower. Thus, the model would not apply to markets with a very low entry cost, small network effects and small values of marketing.

Second, we have assumed that the incumbent has no use of the target's asset to highlight the strategic motive. If the incumbent has use of the target's asset, the analysis will be more involved, but the main insight will be that the value for the incumbent of acquiring the target will increase, and we will predict fewer acquisitions made by the gazelle. However, unless the synergies between the incumbent and target are too large, our analysis above will be valid.

In this study, we have not taken asymmetric information problems into account in detail, such as in the gazelle's venture capital financing. It is likely that the gazelle owner has an informational advantage by knowing the quality of the business idea better than the venture capitalist. In future research, it would be interesting to extend the theoretical model by allowing for asymmetric information.

Moreover, gazelle growth is often characterized by uncertainty both on the demand side and on the technology development side, which might affect the choice of growth mode. In particular, large-scale organic growth might be costly since the time between the onset of the investment and the use of the new plants might be long. Examining these aspects seems to be a fruitful avenue for future research.

Appendix A

A.1. Cournot model

In the Cournot oligopoly model, we consider two firms in an industry: an established market-leading firm, called the incumbent, and an entrepreneurial firm that has recently started up and has the potential to grow quickly, called the gazelle. We characterize each firm with zero total cost except the distribution cost of the gazelle, d , in small-scale organic growth. The firms produce identical goods and are price takers. The market-demand function is given by

$$P(Q) = a - bQ \text{ and } a, b > 0, a > d, \text{ where } Q = q_g + q_i.$$

In this two-seller game, each firm's action is defined as choosing its production level. First, we assume here that both the incumbent and the gazelle choose their actions simultaneously. Thus, each firm j chooses $q_j \in A_j \equiv [0, \infty)$, $j = 1, 2$. Then, the payoff function of each firm j is its profit function, which is defined by: $\pi_j(q_g, q_i) = P(q_g + q_i)q_j - TC_j(q_j)$, where $TC_j(q_j) = 0$, except that

$TC_g(q_g) = dq_g$ under the condition of small-scale organic growth. Based on the simultaneous move assumption, we first calculate the Cournot-Nash equilibrium. The triplet $\{P^c, q_i^c, q_g^c\}$ is a Cournot-Nash equilibrium if the following hold:

- (1) Given $q_g = q_g^c, q_i^c$ solves $\max_{q_i} \pi_i(q_i, q_g^c) = P(q_i + q_g^c)q_i - TC_i(q_i) = \left[a - b(q_i + q_g^c) \right] q_i - 0$ Given $q_i = q_i^c, q_g^c$ solves $\max_{q_g} \pi_g(q_i^c, q_g) = P(q_i^c + q_g)q_g - TC_g(q_g) = \left[a - b(q_i^c + q_g) \right] q_g - dq_g$
- (2) $P^c = a - b(q_i^c + q_g^c), P^c, q_i^c, q_g^c \geq 0$.

The incumbent firm's profit maximization problem yields the first-order condition, given by $\frac{\partial \pi_i(q_i, q_g)}{\partial q_i} = a - 2bq_i - bq_g = 0$. The second-order condition guarantees that a global maximum is satisfied because $\frac{\partial^2 \pi_i}{\partial (q_i)^2} = -2b < 0$ for every q_i and q_g . If we solve for q_i as a function of q_g , we will obtain the best-response function of the incumbent, denoted as $R_i(q_g)$:

$$q_i = R_i(q_g) = \frac{a - bq_g}{2b} = \frac{a}{2b} - \frac{1}{2}q_g.$$

Similarly, we can obtain the gazelle's best-response function from the first-order condition $\frac{\partial \pi_g(q_i, q_g)}{\partial q_g} = a - 2bq_g - bq_i - d = 0$. $R_g(q_i)$ is given by:

$$q_g = R_g(q_i) = \frac{a - bq_i - d}{2b} = \frac{a - d}{2b} - \frac{1}{2}q_i.$$

Due to the difference in the cost structure between the incumbent and the gazelle, their best-response functions do not look exactly the same. The Cournot equilibrium output levels can be calculated by solving these two best-response functions. The Cournot equilibrium quantity for the incumbent is given by

$$q_i^c = \frac{a}{2b} - \frac{1}{2} \left(\frac{a - d}{2b} - \frac{1}{2}q_i \right)$$

$$q_i^c = \frac{a}{2b} - \frac{a}{4b} + \frac{d}{4b} + \frac{1}{4}q_i$$

$$q_i^c = \frac{a + d}{3b}$$

The Cournot equilibrium quantity for the gazelle is given by

$$q_g^c = \frac{a - d}{2b} - \frac{1}{2} \left(\frac{a}{2b} - \frac{1}{2}q_g \right)$$

$$q_g^c = \frac{a - d}{2b} - \frac{a}{4b} + \frac{1}{4}q_g$$

$$q_g^c = \frac{a - 2d}{3b}$$

Hence, the aggregate industry-output level is $Q^c = q_i^c + q_g^c = \frac{2a - d}{3b}$, and the Cournot equilibrium price is $P^c = a - bQ^c = a - b \left(\frac{2a - d}{3b} \right) = \frac{a + d}{3}$.

On the other hand, in our model, the game between the incumbent and the gazelle is a sequential-moves game, called a Stackelberg game in the literature. The incumbent is the leader and moves first, whereas the gazelle is the follower and moves after observing the output level chosen by the incumbent. This game has a continuum of subgames indexed by the output level chosen by the incumbent in the first stage. A finite-horizon dynamic game is generally solved backward. We look for a subgame perfect equilibrium for this game. Therefore, we first analyze the gazelle's action in the last period, assuming that the actions in the previous period are given. Then, we go back one period and analyze the incumbent's action given the strategy of how the gazelle chooses its output level based on the first-period action. In the second period, only the gazelle moves and chooses q_g to maximize its profit, taking the incumbent's quantity produced, q_i , as given. The second-period problem of the gazelle is identical to the problem solved by the gazelle in a Cournot market structure. The maximization gives the same best-response function for the gazelle: $R_g(q_i) = \frac{a - bq_i - d}{2b} = \frac{a - d}{2b} - \frac{1}{2}q_i$. This function $R_g(q_i)$ constitutes the gazelle's strategy for this game. On the other hand, in the first period, the incumbent is able to calculate how the gazelle will best reply to its choice of quantity. The incumbent chooses q_i^s to maximize its payoff function, π_i^s .

$$\max_{q_i} \pi_i^s = P(q_i + R_g(q_i))q_i - TC_i(q_i)$$

$$\pi_i^s = \left[a - \left(\frac{a - d - bq_i}{2b} + q_i \right) \right] q_i - 0$$

$$\pi_i^s = aq_i - bq_i^2 - \frac{a}{2}q_i + \frac{d}{2}q_i + \frac{b}{2}q_i^2$$

$$\frac{\partial \pi_i^s}{\partial q_i} = \frac{a}{2} - bq_i^s + \frac{d}{2} = 0$$

$$q_i^s = \frac{a + d}{2b}$$

As expected, the incumbent produces a higher quantity than the Cournot equilibrium quantity: $q_i^s > q_i^c$.

Under the sequential-moves market structure, we calculate the quantity chosen by the gazelle by substituting q_i^s into $R_g(q_i)$:

$$q_g^s = \frac{a - d}{2b} - \frac{1}{2}q_i^s = \frac{a - d}{2b} - \frac{1}{2} \left(\frac{a + d}{2b} \right)$$

$$q_g^s = \frac{a - 3d}{4b}$$

On the other hand, the quantity level of the gazelle drops compared to the Cournot equilibrium quantity: $q_g^s < q_g^c$.

A.2. Proof of proposition 3

Lemma 1 implies that the firm i with the highest valuation obtains the assets at a price of v_i .

- (i) If $I > \bar{I}(d_s, r)$ and $d_s > d^*$: In this interval, the gazelle g will not undertake large-scale organic growth. It will grow organically on a small scale. On the other hand, it then follows from **Lemma 1** that the incumbent i acquires the target firm and its distribution network at a price of $\frac{\pi_g^D(0)}{1+r}$ when $d_s \geq d^{\max}$ and at a price of $\frac{\pi_g^D(0) - \pi_g^D(d_s)}{1+r}$ when $d_s < d^{\max}$.
- (ii) If $I > \bar{I}(d_s, r)$ and $d_s < d^*$: In this interval, the gazelle g will not be able to undertake large-scale organic growth. However, it then follows from **Lemma 1** that the gazelle g will obtain the target firm's assets at a price $[\pi_i^D(d_s) - \pi_i^D(0)]$ when it makes the acquisition.
- (iii) If $I < \bar{I}(d_s, r)$: In this interval, the gazelle g will grow by acquisition, although it could also choose to grow organically at a large scale. It then follows from **Lemma 1** that the gazelle g obtains the assets at a price of 0 in the case of the acquisition.

A.3. Derivation of equation 8

First, note the following:

$$\begin{aligned} v_i(d) - v_g(d) &= \pi_i^D(d) - \pi_i^D(0) - \left(\frac{\pi_g^D(0) - \pi_g^D(d)}{1+r} \right) \\ &= \pi_i^D(d) + \frac{\pi_g^D(d)}{1+r} - \left(\pi_i^D(0) + \frac{\pi_g^D(0)}{1+r} \right) \\ &= \Pi_i(d) - \Pi_g(0) \end{aligned} \tag{A.1}$$

where $\Pi_i(d) = \pi_i^D(d) + \frac{\pi_g^D(d)}{1+r}$ is the aggregate profit under the incumbent's ownership of the assets and $\Pi_g(0) = \pi_i^D(0) + \frac{\pi_g^D(0)}{1+r}$ is the aggregate profit under the gazelle's ownership of the assets. Hence, distribution costs d affect only profits under the incumbent's ownership. To study how $v_i - v_g$ reacts to changes in d , we can simply explore aggregate profit $\Pi_i(d)$ when the incumbent buys the target firm. The firm's profits under an incumbent's acquisition of the target firm are as follows:

$$\begin{aligned} \Pi_i(d) &= \pi_i^D(d) + \frac{1}{1+r}(\pi_g^D(d)) \\ \pi_i^D(d) &= P(q_i + q_g)q_i \end{aligned} \tag{A.2}$$

$$\frac{1}{1+r}(\pi_g^D(d)) = \frac{1}{1+r}[P(q_i + q_g)q_g - dq_g]. \tag{A.3}$$

The FOCs are as follows:

$$\frac{\partial \pi_i^D}{\partial q_i} = P + P'q_i = 0 \tag{A.4}$$

$$\frac{\partial \pi_g^D}{\partial q_g} = \frac{1}{1+r} \left(P + P'q_g - d \right) = 0 \quad (\text{A.5})$$

$$\Rightarrow P + P'q_g - d = 0.$$

We know that $Q = q_i + q_g$ and $\frac{dQ}{dd} = \frac{dq_i}{dd} + \frac{dq_g}{dd}$. Differentiating (A.4) with respect to q_i , q_g , and d and solving for $\frac{dq_i}{dd}$, $\frac{dq_g}{dd}$ and $\frac{dQ}{dd}$ implies the following:

$$\begin{aligned} \frac{d}{dd} \left(P + P'q_i \right) &= 0 \frac{dP}{dQ} \frac{dQ}{dd} + \frac{dP'}{dQ} \frac{dQ}{dd} q_i + P' \frac{dq_i}{dd} = 0 \\ P' \left(\frac{dq_i}{dd} + \frac{dq_g}{dd} \right) &+ P''q_i \left(\frac{dq_i}{dd} + \frac{dq_g}{dd} \right) + P' \frac{dq_i}{dd} = 0 \\ \left(P' + P'q_i + P'' \right) \frac{dq_i}{dd} &+ \left(P' + P''q_i \right) \frac{dq_g}{dd} = 0 \\ (P' + P' + P''q_i) dq_i &+ (P' + P''q_i) dq_g = 0 \\ \Rightarrow dq_g &= \frac{-(2P' + P''q_i) dq_i}{(P' + P''q_i)} \end{aligned} \quad (\text{A.6})$$

Differentiating (A.5) with respect to q_i , q_g , and d and solving for $\frac{dq_i}{dd}$, $\frac{dq_g}{dd}$ and $\frac{dQ}{dd}$ implies the following:

$$\begin{aligned} \frac{d}{dd} (P + P'q_g - d) &= 0 \\ \frac{dP}{dQ} \frac{dQ}{dd} + \frac{dP'}{dQ} \frac{dQ}{dd} q_g &+ P' \frac{dq_g}{dd} - 1 \frac{dd}{dd} = 0 \\ P' \left(\frac{dq_i}{dd} + \frac{dq_g}{dd} \right) &+ P''q_g \left(\frac{dq_i}{dd} + \frac{dq_g}{dd} \right) + P' \frac{dq_g}{dd} - 1 \frac{dd}{dd} = 0 \\ (P' + P''q_g) \frac{dq_i}{dd} &+ (P' + P''q_g + P') \frac{dq_g}{dd} - 1 \frac{dd}{dd} = 0 \\ (P' + P''q_g) dq_i &+ (P' + P' + P''q_g) dq_g - 1 dd = 0 \\ \Rightarrow (P' + P''q_g) dq_i &+ (P' + P' + P''q_g) dq_g = dd \end{aligned} \quad (\text{A.7})$$

Inserting (A.6) into (A.7), we obtain the following:

$$\begin{aligned} \left(P' + P''q_g \right) dq_i &+ \left(2P' + P''q_g \right) \frac{-(2P' + P''q_i) dq_i}{(P' + P''q_i)} = dd \\ (P' + P''q_i)(P' + P''q_g) dq_i &+ (2P' + P''q_g) [-(2P' + P''q_i)] dq_i = (P' + P''q_i) dd \\ ([(P')^2 + P''P'q_g + P''P'q_i + (P'')^2 q_i q_g] &- [4(P')^2 + 2P'P''q_i + 2P''q_g P' + (P'')^2 q_i q_g]) dq_i \\ = (P' + P''q_i) dd \\ (-3(P')^2 - P''P'q_g - P''P'q_i) dq_i &= (P' + P''q_i) dd \\ \frac{dq_i}{dd} &= \frac{(P' + P''q_i)}{-3(P')^2 - P''P'q_g - P''P'q_i} \\ \frac{dq_i}{dd} &= \left(-1 \right) \frac{(P' + P''q_i)}{P' [3(P') + P''q_g + P''q_i]} = \left(-1 \right) \frac{(P' + P''q_i)}{P' [3P' + P''(q_g + q_i)]} = \left(-1 \right) \frac{(P' + P''q_i)}{P' [3P' + P''Q]} \\ \Rightarrow \frac{dq_i}{dd} &= -\frac{(P' + P''q_i)}{D} > 0 \quad \text{since we know that } P' < 0 \text{ and } P'' < 0 \\ \text{and } D &= P' [3P' + P''Q] > 0. \end{aligned}$$

In summary, when we solve for $\frac{dq_i}{dd}$, $\frac{dq_g}{dd}$ and $\frac{dQ}{dd}$, we obtain the following inequalities:

$$\begin{aligned} \frac{dq_i}{dd} &= -\frac{P' + P''q_i}{D} > 0, \quad \frac{dq_g}{dd} = \frac{2P' + P''q_i}{D} < 0, \\ \frac{dQ}{dd} &= \frac{P'}{D} < 0, \end{aligned} \quad (\text{A.8})$$

where $D = P' [3P' + P''Q] > 0$ and $Q = q_i + q_g$. We can then define the (reduced-form) aggregate profits under incumbent ownership of the assets as a function of d :

$$\Pi_i(d) = \pi_i^D(q_i(d), q_g(d), d) + \pi_g^D(q_i(d), q_g(d), d) \quad (\text{A.9})$$

Taking the total derivative in d and using (A.2), (A.3), (A.4) and (A.5), (A.9) can be written as follows:

$$\frac{d\Pi_i}{dd} = P'q_i \frac{dq_g}{dd} + P'q_g \frac{dq_i}{dd} - q_g \quad (\text{A.10})$$

Using the first-order conditions (A.4) and (A.5) and that $\frac{dQ}{dd} = \frac{dq_i}{dd} + \frac{dq_g}{dd}$ must hold, (A.10) can be rewritten as follows:

$$\begin{aligned} \frac{d\Pi_i}{dd} &= P'q_i \left(\frac{dQ}{dd} - \frac{dq_i}{dd} \right) + \underbrace{[P'q_g] \frac{dq_i}{dd}}_{d-P} - q_g \\ \frac{d\Pi_i}{dd} &= P'q_i \frac{dQ}{dd} - \underbrace{[P'q_i] \frac{dq_i}{dd}}_{-P} + d \frac{dq_i}{dd} - P \frac{dq_i}{dd} - q_g \\ \frac{d\Pi_i}{dd} &= P'q_i \frac{dQ}{dd} + P \frac{dq_i}{dd} - P \frac{dq_i}{dd} + d \frac{dq_i}{dd} - q_g \\ \Rightarrow \frac{d\Pi_i}{dd} &= P'q_i \frac{dQ}{dd} + d \frac{dq_i}{dd} - q_g. \end{aligned} \quad (\text{A.11})$$

Finally, from (A.1), $v_i(d) - v_g(d) = \Pi_i(d) - \Pi_g(0)$. It then follows that

$$\begin{aligned} \frac{d(v_i - v_g)}{dd} &= P'q_i \frac{dQ}{dd} + d \frac{dq_i}{dd} - q_g \\ \frac{d(v_i - v_g)}{dd} &= \frac{dQ(d)}{dd} P'q_i(d) + \frac{dq_i(d)}{dd} d - q_g(d). \end{aligned}$$

This equation is Eq. (8) in Section 3.

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Paper II



Tracing Credit Risk in the Equity Market

Abstract

This paper examines the impact of stock illiquidity in the equity market on credit risk in the debt market. It hypothesizes that less liquid a firm's stock is in the stock market, the higher the firm's credit risk proxied by its CDS spread in the debt market. The paper tests this hypothesis empirically by using panel data of publicly listed nonfinancial firms in North America. The paper considers four different measures of stock liquidity, namely, the measures of bid-ask spread, the Amihud illiquidity, turnover ratio, and zero-return days to ensure the accuracy of the findings. While controlling for other known factors, a one percentage point increase in stock illiquidity leads to a 5.8 percentage points increase in CDS spread in the next quarter. The endogeneity bias in interpreting the causal relationship between these two metrics is addressed through an instrumental-variable analysis that eliminates credit risk effect on stock liquidity measures by using credit ratings.

JEL Classification: G12, G14, G24, G30, G32

Keywords: Credit Risk, Credit Default Swap, CDS spread, Stock Illiquidity, Information Asymmetry, Market Interconnectedness, Credit Ratings

1 Introduction

The interconnectedness between credit and equity markets is an essential phenomenon to a large number of stakeholders, including investors, bankers, brokers, and regulators. Investors increasingly use signals from both markets in connection with evaluating firm value and firm credit risk. Among various credit markets, the credit default swap (CDS) market has received particular attention due to its rapid growth before the financial crisis and its shrinkage afterwards. Das et al. (2009) describe CDS as “a default insurance contract in which the buyer pays the seller a periodic premium in return for compensation in the event of default of a reference firm”.^{1 2} In the wake of the 2007 financial crisis, liquidity risk and liquidity commonality between the equity market and the CDS market have been an important discussion topic. However, little is known about how the illiquidity of a firm’s stock in the equity market may affect the firm’s credit risk in the debt market. The purpose of this paper is to fill this gap.

The starting point of this study is that the illiquidity of a firm’s stock should contain information about the underlying firm value and the firm’s performance in the future. This study hypothesizes that if a firm’s stock has a lower liquidity in the equity market, the firm’s CDS spread in the credit market will be higher. The basic argument for this hypothesis is asymmetric information. The efficient market hypothesis (EMH) (Malkiel and Fama, 1970) postulates that stock prices reflect all available information. If potential buyers and sellers have asymmetric information about the firm value as well as the firm’s prospects, it is likely that buyers’ and sellers’ stock valuations will differ substantially, and the stock will be illiquid in the market. This effect strengthens if few investors have invested in gathering information about the firm. In such cases, the uncertainty of the firm’s future earnings should be high. The CDS market might therefore assesses stock illiquidity associated with asymmetric information about the firm’s value and the firm’s prospects as increased credit risk associated with the firm.

¹Hull (2003) defines credit derivatives as contracts in which the payoff depends on the creditworthiness of one or more entities. Ericsson et al. (2009) further explain that these types of instruments allow credit risk to be traded separately from other sources of uncertainty. The most widely used type of credit derivatives is the credit default swaps (CDS). Hull (2003) argues that CDS should be considered a type of insurance against the default risk of a company.

²Annaert et al. (2013) argue that CDS spreads represent the market’s view on the financial stability of the reference entity of a CDS contract.

Credit derivatives and credit default swaps were pioneered in the late 20th century, and after a period of steady development, the derivatives market grew tremendously in the early 2000s. This rapid growth is believed to have arisen from the desire of banks and insurance companies to hedge their bond and loan exposures and from the willingness of hedge funds to trade highly liquid instruments to speculate on credit risk (Tang and Yan, 2008, 2010; Hirtle, 2009; Subrahmanyam et al., 2017). In a CDS contract, the protection buyer purchases insurance against a credit event of a pre-specified reference entity from the protection seller. For that protection, the buyer pays a regular premium, whereas the seller commits to compensate the buyer if a credit event occurs (Aldasoro and Ehlers, 2018). A credit event might be a case of bankruptcy, nonpayment of debt, and, in some CDS contracts, debt restructuring (Oehmke and Zawadowski, 2017). CDS spreads thus convey information on the financial soundness of a firm. (Annaert et al., 2013).

By using CDS and stock market data as well as firm financial statement data from Capital IQ, we can test the hypothesis that stock market illiquidity should increase CDS spreads in a sample that consists of 270 firms over the period between 2004 and 2016. Stock illiquidity has two main dimensions: transaction price and volume. We consider four different measures, namely a bid-ask spread measure, the Amihud illiquidity measure, turnover measure, and a zero-return days measure.

The main finding of the paper is that an increased illiquidity of a firm’s stock in the equity market leads to an increase in the CDS spread of the same firm in the next fiscal quarter. This empirical result is statistically significant for the bid-ask spread measure, the Amihud illiquidity measure, and the zero-returns days measure. A one percentage point increase in stock liquidity measured by the bid-ask spread leads to 5.8 percentage points increase in CDS spread in the next quarter.

By using a quasi-instrumental variable methodology, we try to address the endogeneity concern stemming from reverse causality. One might argue that the market for the stock of a firm with a high credit risk might be illiquid. The higher credit risk that increases information asymmetry about the firm value might prevent investors from buying and selling the firm’s stock. A high credit risk of the firm might lead to its stock being illiquid. Therefore, we try to remove the possible effect of credit risk that might have already been embedded in the stock illiquidity variable. Additionally, as we do in the main empirical methodology,

we always lag by one fiscal quarter of all the explanatory variables, including stock liquidity measures. The quasi-instrumental variable approach also leads to the conclusion that stock illiquidity measured by the bid-ask spread and the Amihud illiquidity measures, increases the CDS spread in the next quarter.

The existing empirical literature examining the relationship between the liquidity of a firm's stock and the firm's CDS spreads is sparse. Das and Hanouna (2009) observe slight evidence of a relationship between stock market illiquidity and CDS spread using a mechanism based on hedging. However, this paper differs in several aspects. First, the paper's theoretical starting point is that asymmetric information problems associated with a firm's value and its future performance will affect the illiquidity of the firm's stock in the equity market, and this illiquidity pattern will affect the firm's credit risk perceived by the CDS market. Second, Das and Hanouna (2009) examine a smaller sample that consists of 195 publicly owned firms. More importantly, the researchers' sample period is from 2001 to 2005, and only a period before the 2007 financial crisis is considered. However, this paper's sample comprises 270 firms, and the sample period is from 2004 to 2016, covering the period after the 2007 financial crisis. Third, the empirical analysis in this paper is distinct from that of Das and Hanouna (2009) in controlling for not only time fixed effects but also firm fixed effects. Finally, we also use a quasi-instrumental variable approach to analyze the reverse causality problem.

The paper proceeds as follows. Section 2 provides background information on CDS and the respective market. Section 3 contains the literature review and explains the paper's contribution to the literature. Section 4 describes the theoretical frameworks for the main independent variable, namely, stock illiquidity, as well as control variables. Section 5 presents the data, variable construction, descriptive statistics, and an empirical model. Section 6 provides the main empirical analyses. Section 7 addresses the endogeneity bias that arises in the causal interpretation. Finally, Section 8 concludes the paper.

2 Background on Credit Derivatives and Credit Default Swaps

Credit derivatives emerged in financial markets in the 1990s, having been pioneered by JP Morgan. The most common type of credit derivative is a credit default swap (CDS). CDS

became one of the most common instruments used to assess the market's perception of the financial stability of companies and sovereign countries (Annaert et al., 2013). The CDS market developed steadily in the early 1990s, but then saw a period of unprecedented growth in the early and mid-2000s. By 2007, the gross notional amount of outstanding CDS contracts rose to ca. \$58 trillion (Bank for International Settlements (BIS), November 2008). Tang and Yan (2012) argue that this growth stems from the need of banks and insurance companies to hedge their bond and loan exposures and from hedge funds' willingness to use CDS as a tool to speculate on credit risk. However, the CDS market had shrunk since 2007 and it dropped to \$15 trillion by June of 2015 (BIS, November 2015).

There are three main market participants in the CDS market (Minton et al., 2005). The largest group in this market is large commercial banks, which are net buyers of credit derivative protection. First, such commercial banks are exposed to credit risk in their traditional business due to the large amounts of corporate loans in their portfolios. Second, such commercial banks also hold corporate bonds as investments on their balance sheets. The CDS market provides such banks with the opportunity to transfer credit risk without removing the loans from their balance sheets and without involving obligor corporations directly. These two features do not exist in the case of securitization, an alternative way for commercial banks to diversify their loan or investment portfolios' risk. Another advantage of the CDS market is that it allows banks to diversify their loan portfolios that are often concentrated in specific sectors and geographical regions. The second-largest group in the CDS market is insurance companies that have net sold positions in the CDS market globally (BIS, November 2015). By trading credit default swaps and other credit derivatives, insurance companies try to diversify their exposure to risks that are uncorrelated with their existing insurance business and increase their investment yields. The third-largest group in the CDS market is hedge funds. To implement their sophisticated arbitrage strategies across different financial markets, hedge funds utilize credit derivatives and specifically CDS heavily as both protection buyers and sellers. In addition to these three main groups, there are miscellaneous participants in the CDS market, such as pension funds, loan book traders and financial guarantors.

CDS is an over-the-counter contract between two parties that provides protection against credit risk to the buyer. In this insurance contract for credit risk, the protection buyer pays a fixed premium called spread to the protection seller for a period of time. If a particular pre-specified credit event occurs to a specific company, called the reference entity, the

protection seller pays compensation to the protection buyer. The reference entity can be a corporate loan, a corporate bond, a municipal bond or a mortgage-backed security. In a CDS contract, the reference entity is not a party to the contract, and neither the buyer nor the seller is required to obtain the reference entity's consent to enter into a CDS contract. Failure to pay debts, bankruptcy, and restructuring of the reference entity can be counted as typical examples of credit events in CDS contracts. Consider an example where the protection buyer holds a bond issued by a reference entity such as a reference company. In case of a credit event involving the reference company, the protection seller either can make the compensation payment in the form of a lump sum payment equal to the difference between the value of the reference entity's bond and the bond's face value or can deliver the reference entity's bond to the protection seller for its face value. In case of no credit event occurring during the term of the swap, the protection buyer continues to pay the CDS premium to the seller until the contract's maturity. The diagram in Figure 1 summarizes the mechanism of CDS as a financial derivative product.

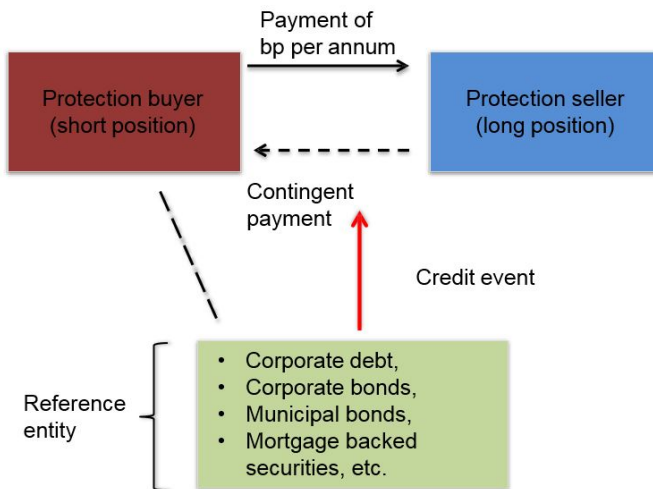


Figure 1: The Mechanism of Credit Default Swap

The CDS premium paid by the protection buyer to the seller is quoted in annual basis points of the contract's notional value, which often equals USD 10 million. The premium is

usually paid quarterly. For example, suppose that the CDS spread for a five-year USD 10 million contract on the Ford Motor Company (the reference entity) is 125 basis points, and the credit event is defined to be a default of the Ford Motor Company's bonds. Citibank, which lends to Ford Motor Company or owns Ford Motor Company's bonds as an investment, wants to protect its loan or investment portfolio against the credit risk of Ford Motor Company. As a protection buyer, it pays USD 31,250 ($1.25/4$ percent of USD 10 million) per quarter to the protection seller – let's assume the latter to be an insurance company, MetLife Inc., in our example – for five years or until the Ford Motor Company defaults on its bonds. In the latter event, the protection buyer (Citibank), in turn, has the right to sell the Ford Motor Company's bonds to the protection seller (MetLife Inc.) for their face value of USD 10 million. In CDS contracts, maturities range from one to ten years, with the five-year maturity being the most common.

CDS contracts can be written on either a single entity, with such contracts called "single-name" CDS, or many reference entities, with the respective contracts called "multi-name" CDS. CDS indices that reference a basket of underlying single-name CDS such as the Markit iTraxx indices in Europe that consist of CDS contracts written on European corporations are the most common example of multi-name CDS. In such CDS, the fair value of the index is essentially the aggregate value of the underlying reference CDS. However, the single-name CDS (also called the corporate single-name CDS) is the most common, and thus liquid credit derivative. Interdealer brokers facilitate the transactions in the CDS market. Even though some corporations' CDS are traded daily or even multiple times within a day, a large number of contracts are traded every few days or even weekly (Tang and Yan, 2012). Tang and Yan (2012) further argue that this issue should raise awareness of the information content of CDS and also shows the importance of liquidity in CDS pricing.

Das and Hanouna (2009) postulate that "the periodic payment or spread, taken as a percentage of the notional value of the CDS contract, is a metric of the credit risk of the reference firm and it is also a forecast of the expected loss on a reference bond issued by the reference issuer". A firm defaults when it is unable to meet its obligations to its debt holders. Thus, default risk causes lenders to demand from borrowing firms a spread over the risk-free rate of interest. A higher default risk implies a higher spread paid by a borrower to borrow funds, as well as a higher CDS spread. In other words, the spread is an increasing function of the default risk (Merton, 1974 and Vassalou & Xing, 2004).

3 Literature Review

In recent years, several researchers have performed studies of the different impacts that certain variables have on credit risk and, more specifically, credit default swap spreads. Such notable studies include those of Ericsson, Jacobs, and Oviedo (2009); Annaert, De Ceuster, Van Roy and Vespro (2013); Das and Hanouna (2009); Alexander and Kaeck (2008); Callen, Livnat, and Segal (2009); and Kapar and Olmo (2011).

Ericsson, Jacobs, and Oviedo (2009) investigate CDS data and analyze the relationship between the market CDS premium and factors such as firm leverage, riskless interest rate, and volatility. By using linear regressions, the researchers show that the coefficients of all of these three determinants are significant both statistically and economically. In turn, Annaert, De Ceuster, Van Roy, and Vespro (2013), inspired by the Merton Model (1974), determine the impact of certain credit risk drivers on CDS spread changes of 31 European banks. The above article also examines and compares how the determinants of CDS spreads changed before and after the financial crisis. The authors find that these determinants vary widely over time. They suggest that researchers should frequently estimate their models testing the determinants of CDS spread changes to examine the whole picture. They also find that the CDS market liquidity plays an essential part in explaining Euro-area bank CDS changes both before and after the financial crisis, while variables suggested by credit risk models became considerably more significant after the onset of the financial crisis (Annaert et al., 2013).

The conclusions of Annaert et al. (2013) are also consistent with the findings of the study by Kapar and Olmo (2011), that distinguishes between nonfinancial and financial firms. The researchers argue that before the financial crisis, credit risk in the CDS market was sufficient to explain the overall credit risk; during the financial crisis, nonfinancial CDS contracts were still closely related to the counterparty credit risk, while financial contracts were not. Kapar and Olmo (2011) suggest that this occurred mainly because, in case of default of a financial firm, investors would expect government intervention intended to avoid a possible domino effect and manage systemic risk.

De Jong and Driessen (2005) show that equity market illiquidity is priced into bond spreads. Das and Hanouna (2009) link equity markets and CDS spreads via a hedging mechanism. The authors claim that since CDS contracts are actively hedged, unlike bonds,

illiquidity costs from equity markets are transmitted into CDS spreads. However, in the study of Das and Hanouna (2009), the sample spans the period from 2001 to 2005 and misses the financial crisis in 2007. Alexander and Kaeck (2008) demonstrate that CDS spreads “display pronounced regime specific behavior”. The cited study shows that during CDS market turbulences, spreads are highly sensitive to stock volatility, while in ordinary periods the spreads are more sensitive to stock returns rather than stock volatility. The above study also reveals that interest rates, stock returns, and implied volatility have a significant effect on CDS spreads. These findings are consistent with previous studies undertaken by Ericsson et al. (2009) and Byström (2005).

Finally, Callen, Livnat, and Segal (2009) investigate the impact of earnings on credit risk in the CDS market. The researchers conclude that the earnings of reference firms are negatively correlated with CDS premiums. This result is consistent with the fact that earnings display information regarding the credit risk of firms. Moreover, Callen et al. (2009) observe that CDS premiums are more correlated with earnings of low-rated firms rather than with earnings of higher-rated firms.

This paper contributes to the literature in many ways. First, this study analyzes the relationship in a larger sample than do previous studies by controlling for time-invariant characteristics at the firm and industry levels as well as common time-series effects across firms. Second, it considers the effects of well-known fundamental metrics of firms as control variables. Third, it attempts to establish the causal relation from stock liquidity to CDS spread as much as possible by addressing the endogeneity bias. The paper devises an instrumental-variable methodology to alleviate the endogeneity bias in the relationship between CDS spread and stock liquidity. It is reasonable to argue that a downgrade in a firm’s credit rating and thus an increase in CDS spread may trigger illiquidity of the firm’s stock in the equity market.

Furthermore, this research extends the literature focusing on liquidity commonality, including the degree to which liquidity levels co-move both within and across markets. Prior studies show that higher liquidity commonality leads to systematic shocks and dry-ups of liquidity within and across the equity, option, and bond markets (Chordia et al., 2005, Goyenko & Ukhov 2009). The current paper explores whether the equity market impacts the credit market, specifically the CDS market, through the spillover of liquidity (illiquidity).

Any change in the liquidity of a firm's stock provides an informative signal to investors in CDS markets about the value of the underlying firm used as a reference entity in the CDS agreement. Therefore, stock liquidity is a factor that needs to be taken into account in CDS pricing. This study might be of particular interest to researchers and regulatory authorities as they use CDS spreads to investigate any possible warning signals regarding the financial health of an entity.

4 Theoretical Framework

4.1 Main Independent Variable: Stock Liquidity

The Merton model (1974) considers equity and debt as claims on the same underlying asset; therefore, their prices should reflect the same information about the fundamental risk related to a firm. Due to the interaction between the stock market and the debt market, which both assess the credit risk of a firm, there should be a relationship between stock liquidity and credit risk.

The efficient-market hypothesis (EMH) posits that any asset price reflects all available information (Malkiel and Fama, 1970). A stock price has different dimensions. Two of them are stock return and stock volatility. The Merton model (Merton 1974) posits that stock return and stock volatility are two features of stock that influence credit risk. Based on the EMH and the Merton model, this study predicts that the third feature, stock illiquidity, should also affect credit risk since illiquidity itself signals uncertainty about the underlying firm value that makes up the stock value. This study argues essentially that a firm's stock illiquidity should provide information about the firm value and its performance in the future.

When a firm's stock is not traded frequently and illiquidity increases, the stock price loses its ability to "fully reflect" available information to the investors. The condition of lacking information or, at least, having less than the full information available, implies increased credit risk of the firm. The main reason for this condition is asymmetric information. When potential sellers and buyers have asymmetric information about the firm value and the firm's prospects, their valuations of the stock differ substantially, and they do not trade the stock. Therefore, the firm's stock becomes illiquid. This condition of asymmetric information worsens if neither potential buyers have invested in gathering information about the firm nor have the sellers as the owners of the stock disseminated more information about the firm to

the market. Therefore, this study hypothesizes that if a firm's stock has a lower liquidity in the equity market, the firm's CDS spread in the debt market will be higher.

The illiquidity of the stock signals negative information about the firm and its credit-worthiness implying that either the potential investors do not want to trade the stock under the current circumstances or at least the illiquidity of the stock prevents stock prices from playing their role of reflecting all information available about the firm to the markets. Stock liquidity matters for CDS spreads because equity and credit markets are interconnected. Since equity and debt are claims on the same underlying asset, namely, the firm value (the Merton model, 1974), once a stock is not traded frequently enough or in sufficient amounts, investors in the CDS market will interpret this as an increased credit risk due to the information asymmetry and the potential loss of information about the firm known to the market, which liquid trading in the equity market would otherwise provide to investors.

When a firm has a higher credit risk, the consequence is not only the debt market's reaction to this but also the equity market's adjusting itself by a decrease in transactions in the shares in the equity market. Friewald et al. (2014) conclude that the credit risk premium extracted from a CDS spread is strongly and positively related to Merton's (1974) equity risk premium. The firm's stock illiquidity can thus be viewed as increased credit risk, resulting in a raised CDS spread of that firm.

Investors and debt holders have a chance to observe stock markets with more facility than they can observe credit markets because the former are more developed and more liquid. For instance, Gunther et al. (2001) argue that the stock market is a source of information for bank supervisors. The researchers observe that "markets for common shares are fairly liquid, and so the quality of the price signals is reasonably high. Moreover, equity values are sensitive to changes in the condition of the issuing firm, making those changes easier to observe in share prices" (Gunther et al., 2001).

The literature provides theoretical and empirical evidence of the interdependence of stock and credit markets. Kwan (1996) argues that corporate bonds are financial instruments that are a hybrid of the firm's stock and default-free bonds. The same theoretical argument might be valid for CDS, another financial instrument with the value that is also dependent on the credit risk of a firm, similar to the value of corporate bonds. De Jong and Driessen (2005)

point out the correlation between the returns on corporate bonds, the returns on the Treasury bond market, and the returns on the stock market. The authors find, while controlling for market risk using a stock market index and equity index volatility, that corporate bond returns are positively related to changes in the equity and bond market liquidity measures.

Moreover, Fung et al. (2008) describe a direct relationship between the stock market and specifically the CDS market, considering stock market volatility and pricing in the CDS market. These authors investigate the mutual feedback of information between the two markets and argue that the stock market tends to lead the investment-grade CDS market in terms of pricing. We suggest that if the volatility of the stock market has an interaction with the CDS market, then the relationship between the CDS market and another feature of the stock market, its liquidity, deserves to be analyzed. Market interconnectedness should be mediated through liquidity in addition to volatility.

Rösch and Kaserer (2014) search for the existence of a liquidity cost spread in the stock market between companies with high credit quality and those with low credit quality. The researchers observe that investment-grade stocks' liquidity costs are approximately 5% less than those of speculative-grade stocks, implying that stock market liquidity costs increase with credit risk. This finding is consistent with the expectation that a higher credit risk of a firm manifests itself as illiquidity of that firm's stock. Investors in the CDS market who observe this change demand a higher CDS spread for that firm. Rösch and Kaserer (2014) comment that during crisis periods, credit risk intensifies and investors become more risk-averse, thereby choosing liquid instruments. Therefore, the relationship between liquidity in the stock market and the CDS market strengthens (Rösch and Kaserer, 2014). In this research, we claim that the liquidity of a firm's shares in the stock market is an informative signal of lower credit risk of that firm.

To the best of our knowledge, the relationship between stock liquidity and CDS spreads has not been analyzed until now except for one study performed by Das and Hanouna (2009). The authors theorize and confirm that "credit default swap spreads are directly related to equity market liquidity; in their data, equity market illiquidity is a component of CDS spreads at the individual firm level, and this illiquidity component increases as the credit quality of the firm declines". Das and Hanouna (2009) argue that a standard approach in the financial world is to actively hedge CDS contracts, which induces hedging costs to be incurred

regardless of whether liquidity risk is systematic. The authors establish the transmission mechanism between equity market illiquidity and CDS spreads through hedging and do not control for firm fixed effects in their empirical methodology. On the other hand, this study explains the relationship between equity market illiquidity and credit risk proxied by a CDS spread through the mechanism of information content of stock prices and manages to test this relationship by controlling for both time fixed effects and firm fixed effects.

Liquidity is a subtle concept in the sense that it is not directly observable, and is composed of numerous aspects that are not captured in one measure (Amihud, 2000). De Jong and Driessen (2005) postulate that a stock is considered liquid if large volumes of it can be traded without generating much price impact. As this definition states, liquidity has at least two dimensions: volume and price. We use four different measures of illiquidity (liquidity) to capture various aspects of illiquidity while analyzing stock illiquidity's effect on credit risk. These measures are the bid-ask spread measure, the Amihud measure of illiquidity, the turnover ratio measure, and the zero-return days measure.

It would be better to explain and compare these measures so that one can understand the theoretical framework of how they measure stock illiquidity (liquidity). Amihud (2000) argues that the bid-ask spread is a liquidity measure related to price impact. According to the classification of Spiegel and Wang (2005), the bid-ask spread is considered a cost-based measure of liquidity that examines the loss a trader incurs from a transaction. A high bid-ask spread implies illiquidity of a particular stock. Another type of measures, according to the same classification, is the class of reflective measures. The latter includes the volume of traded shares and are thus associated with different characteristics. These reflective measures focus on the volume, ignoring the costs related to trading those shares (Spiegel and Wang, 2005). Both the Amihud's measure of illiquidity and the turnover ratio include the volume of traded shares in their formulas. However, the Amihud's measure of illiquidity also touches upon the price impact by taking into account the dollar volume of traded shares as well as the absolute value of returns in its calculation.

On the other hand, the turnover ratio relies solely on the volume of traded shares and the total number of total shares outstanding to assess liquidity. A higher Amihud illiquidity measure implies a higher CDS spread, whereas a higher turnover ratio indicates a higher liquidity and thus a lower CDS spread. Furthermore, we also utilize the incidence of zero

returns based on transaction costs' idea to measure the illiquidity of a stock. The zero-return days measure can be classified as both a cost-based measure and a reflective measure. The premise of this measure is that a marginal investor will either reduce trading or prefer not to trade if the value of the information signal is insufficient to overcome the costs of trading (Lesmond et al., 1999). This scenario leads to a zero return.

4.2 Control Variables

While examining the impact of stock liquidity on credit risk measured by a CDS spread, we control for other known determinants of credit risk. Stock return, equity value, equity (stock return) volatility, market leverage, and profitability are other credit risk factors that we utilize in this study. In this section, we motivate the theoretical reasoning of each control variable by referring to previous studies.

One of the main control variables based on the Merton (1974) model is the stock return. It reflects a company's future prospects such as earnings and cash flows. By using equity returns as a proxy for asset returns in that model, we test whether the equity market information affects CDS spreads. The theory suggests that the higher the stock returns are, the lower the probability of default and the credit risk; as a result, we expect a lower CDS spread. Zhu (2006) shows that CDS spreads are quite responsive to changes in stock returns. However, Annaert et al. (2013) observe that credit risk determinants, including stock return, from the Merton (1974) model were the major determinants of CDS spreads before 2006, while in the period just before the financial crisis and during the financial crisis these drivers became insufficient for explaining the variation in CDS spreads.

Another control variable we select is the equity value. It is a proxy that measures the firm value, as proposed by the Merton (1974) model, since the firm value is not observed directly. Alexander and Kaeck (2008) argue that if the market value of a firm increases, the probability of default decreases. The researchers also comment that changes in a firm's equity value will be the primary determinant of changes in the firm value, and that structural models indicate that upward trends in the equity level are accompanied by decreases in the CDS spread.

As underscored by Alexander and Kaeck (2008), equity volatility is another theoretical determinant of credit default swaps. The probability of default increases, as does the credit

risk, as the fluctuations in firm value become more frequent and larger in scale. However, neither firm value nor its volatility can be directly observed. Existing studies use equity volatility as a proxy for volatility of the firm value based on the Merton (1974) model. The positive relationship between equity volatility and firm value volatility (asset volatility) is described by Ito's Lemma in the Merton (1974) model. Alexander and Kaeck (2008) document that the fluctuations in the value of a firm's shares cause inherent instability within that firm leading to an increase in credit risk and default probability. Greatrex (2009) supports this argument by showing that an increase in equity volatility causes a decrease in the value of the firm's risky debt and an increase in CDS spreads of that firm. Following Alexander and Kaeck (2008), we will use stock return volatility as a representation of equity volatility. Quarterly standard deviations will be computed using daily stock returns within each respective quarter.

Leverage is regarded as the central determinant of credit risk in all credit risk models (Ericsson et al., 2009). In a general sense, equity and debt are claims on the firm's assets that constitute the firm value. The Merton (1974) model regards equity as a call option written on the firm value, whereas debt is regarded as a short put option written on the firm value. As a structural model, the Merton (1974) model defines the state of default as that of the asset value of a firm being less than the value of the firm's debt at maturity. Thereby, default becomes a function of the capital structure (Greatrex, 2009). Capital structure and debt structure explicitly give signals about the credit quality of a firm. The research performed by Rauh and Sufi (2008) reveals that low-credit-quality firms are more likely than good-credit-quality firms to have a multi-tiered capital structure consisting of both secured bank debt with tight covenants and subordinated non-bank debt with loose covenants.

In summary, leverage is a core factor in determining the default risk, and ultimately CDS spreads. As the leverage of a firm increases, its credit risk rises, and consequently its CDS spread increases as well. As the Merton (1974) model theoretically suggests, leverage is calculated based on the market value of debt rather than its book value to not be restricted by accounting data. However, the market value of debt is not readily observable, and due to the different types of debt that firms have on the balance sheet (with differences in convertibility, maturity and seniority), computing the total market value of all of these types of debt is difficult. Therefore, we use book values for debt, as the Merton (1974) model itself does so while calculating the numerator of the leverage ratio. On the other hand, we use the market

value of equity in the denominator (Frank & Goyal, 2009). The so-called market leverage in this study is calculated by dividing the book value of total liabilities by the sum of the book value of total liabilities and the market value of equity. This ratio shows the proportion of assets that are financed with debt.

A firm's profitability is another firm characteristic variable that influences the credit risk of the firm, and thereby its CDS spreads. Based on the Merton (1974) model, a higher asset value implies a lower distance-to-default and, therefore, a lower default risk. The latter implies a lower credit risk, and a lower CDS spread altogether. A company's earnings are the primary financing sources for its asset growth. As a consequence, net income is an essential component of a company's future prospects. These ideas have been researched by Callen, Livnat, and Segal (2009), who find in their study that "earnings of firms are negatively and significantly correlated with the level of CDS premiums, consistent with earnings (cash flows, accruals) conveying information about default risk and credit risk." Besides, the profitability of a publicly owned company may influence its stock price performance and its stock return volatility, two of the control variables in this study. We choose net income as a proxy for a company's earnings because it is the net profit or loss figure showing a company's performance in its business activities. We opt to use it as a ratio by dividing it by total assets to accommodate size differences between different companies and for a better comparison across companies.

5 Methodology

5.1 Data and Variable Construction

Credit Default Swap Spread

In gathering the data for credit default swap spreads, we use the CapitalIQ database. The sample consists of 324 firms' data over a period of 12 years and six months from January 2004 to June 2016. We select the firms that operate in nonfinancial sectors. We exclude banks and insurance companies from the sample because they have different financial reporting standards and distinct business risk types relative to companies in other industries. These differences are likely to create biases in comparisons to other non-financial firms, especially with regards to the calculation of variables based on accounting figures. The resulting 324 firms are selected from North American stock markets. The currency used in the analy-

ses is the US dollar since the vast majority of the firms have CDS contracts traded in this currency, and the majority of the firms in the sample are from the USA, with fewer from Canada. We use CDS spreads in single-name contracts with the five-year maturity since these are regarded as the most actively traded CDS contracts; for example, researchers such as Meng and Gwilym (2008) prove that CDS with the five-year maturity are the most liquid type of CDS.

In this research, we obtain CDS data from the CapitalIQ database daily. The CDS spread prices are provided in basis points. On the one hand, daily frequency is the most common type of CDS spread price frequency used in the literature (Ericsson et al., 2009). On the other hand, in regressions we opt to use quarterly frequency for CDS spreads by taking an average of daily CDS spreads' mid-market prices over a quarter. The CDS spread mid-market price is the average of bid and ask prices of the CDS spread on a given day. Furthermore, we represent CDS spreads as percentages rather than basis points in regressions. Thus, we divide the quarter's average CDS spreads by 100. By computing them at a quarterly frequency, we obtain approximately 12,000 quarterly observations of CDS spread for panel data regression analysis.

There are two main reasons for me to use quarterly frequency in regressions. First, CDS spread data does not change drastically from one day to the next. Tang and Yan (2012) confirm this observation by highlighting that many companies' CDS contracts are traded every few days or even weekly instead of daily. Therefore, encountering a large amount of noise in the daily data is unavoidable. Representative studies that do not use daily frequency CDS data in their analyses include those of Annaert et al. (2013) and Das & Hanouna (2009). Second, some of the control variables obtained from financial statements are available at the quarterly frequency at most. One might think that doing the regression analysis quarterly might take away some trends and information in the data. Thus, some regressions are also performed monthly by excluding the control variables that are not available at the monthly frequency. The direction and the economic and statistical significance of the monthly regressions' results do not differ those of the quarterly regressions. These monthly regressions' results are provided in the appendix in Table XI to Table XIV.

Stock Liquidity Variables

The data collection for the main explanatory variable is based on daily observations of stock prices as well as daily volumes of traded stocks obtained from CapitalIQ. We use four proxies for stock liquidity that are based on the bid-ask spread, stock return, the number of days with zero stock return, volume of traded stocks, and the total number of outstanding shares.

The first measure we use for stock liquidity is the bid-ask spread. We collect daily bid and ask prices for each stock to compute the bid-ask spread measure of liquidity. A higher bid-ask spread measure indicates lower stock liquidity. Data on the bid (the bid price quoted at the close of market) and ask (the ask price quoted at the close of market) prices of stocks are available on CapitalIQ. After calculating the daily bid-ask spreads divided by their average, we average these values over a quarter to obtain quarterly data. In the calculation of the bid-ask spread, we use the following formula:

$$bas_{iq} = \frac{1}{D_{iq}} * \sum_{t=1}^{D_{iq}} [| bidp_{iqt} - askp_{iqt} |] / \frac{bidp_{iqt} + askp_{iqt}}{2} \quad (1)$$

where bas_{iq} is the bid-ask spread measure of stock i for quarter q , D_{iq} is the number of days for which data are available for stock i in quarter q , $bidp_{iqt}$ is the bid price of stock i quoted at the close of market on day t of quarter q , and $askp_{iqt}$ is the ask price of stock i quoted at the close of market on day t of quarter q . We multiply the obtained ratio by 100 to represent it as a percentage.

In the construction of the Amihud illiquidity measure, we collect the volume of traded shares and the closing price on a particular day from CapitalIQ. Afterwards, we calculate the USD value of all shares traded on that day by multiplying the price of the stock quoted in USD by the volume of traded shares. Subsequently, we deflate this value to 2009 dollars using the quarterly consumer price index obtained from the Federal Reserve Bank of St. Louis. The absolute returns are calculated by taking the absolute values of daily logarithmic returns. Next, we take the average of each quarter to obtain quarterly data used to calculate the Amihud illiquidity measure. We base our computation on the study of liquidity measures developed by Amihud (2000). Higher Amihud illiquidity measures also imply lower stock liquidity. The Amihud illiquidity measure used as a proxy of stock illiquidity is defined as follows:

$$illiq_{iq} = \frac{1}{D_{iq}} * \sum_{t=1}^{D_{iq}} \left[(|r_{iqt}|) / \frac{vtr_{iqt}}{cpi} \right] \quad (2)$$

where $illiq_{iq}$ is the Amihud measure of illiquidity of stock i in quarter q , D_{iq} is the number of days on which data are available for stock i in quarter q , r_{iqt} is the return on stock i on the day t of quarter q , vtr_{iqt} is the respective total value of traded stock in dollars, obtained by multiplying the volume of traded shares by the closing price of stock i on the day t of quarter q , and cpi is the quarterly consumer price index with base year 2009.

The third proxy used for stock liquidity measure is the turnover ratio. We collect the volume of traded shares and the total outstanding shares for each firm on a particular day. Both datasets are available in Capital IQ daily. In the calculation, we first compute the daily ratios of volume of traded shares divided by the total number of shares and subsequently average these ratios over a quarter. We multiply the final ratio figure by 100 to represent it as a percentage. In contrast to the other three measures, the higher the turnover ratio is, the greater the stock liquidity. The formula for the turnover ratio measure is as follows:

$$trnvr_{iq} = \frac{1}{D_{iq}} * \sum_{t=1}^{D_{iq}} \left[volshrs_{iqt} / nshrs_{iqt} \right] \quad (3)$$

where $trnvr_{iq}$ is the turnover ratio of stock i in quarter q , D_{iq} is the number of days on which data are available for stock i in quarter q , $volshrs_{iqt}$ is the volume of trading in shares of stock i on day t in quarter q , and $nshrs_{iqt}$ is the number of shares of stock i outstanding on particular day t of quarter q .

The last proxy we use for stock liquidity is the zero-return days measure. It is the ratio of the number of trading days with zero return to the total number of trading days during a quarter. It is also represented in percentage terms. A high zero-return days measure indicates a low stock liquidity.

$$zero_{iq} = \frac{zeroret_{days}_{iq}}{ntrdays_{iq}} \quad (4)$$

where $zero_{iq}$ is the zero-return days measure of stock i in quarter q , $zeroretadays_{iq}$ is the number of trading days when the stock return is zero, and $ntrdays_{iq}$ is the total number of trading days in a quarter.

Control Variables

The control variables that we use are stock return, market capitalization as a measure of equity value, equity (stock return) volatility, market leverage, and profitability. As discussed above, the published literature considers these variables to be significant factors in explaining CDS spreads.

One of the main factors affecting a CDS spread is stock return, according to the Merton (1974) model. As mentioned above, stock prices are collected from CapitalIQ with a daily frequency and are the official closing prices for the individual stocks. We use these stock prices to calculate logarithmic daily returns using the formula $LN(p_t/p_{t-1})$, where p denotes the closing price of the stock. We use logarithmic returns rather than simple returns due to a few reasons. First, the former are interpreted as continuously compounded returns, thus facilitating comparisons across assets; second, logarithmic returns have a symmetric normal distribution (Roberts & Whited, 2013). Alexander and Kaeck (2008) use daily stock returns in their analysis of CDS spreads. However, we use quarterly stock returns and thus calculate the quarterly average of daily stock returns. Moreover, we multiply these return figures by 252 to convert them into annual returns and then by 100 to represent them as percentages.

Another important factor determining a CDS spread is firm value. We use the market capitalization as a measure for the firm value, as the Merton (1974) model utilizes equity value as a proxy for the firm value. CapitalIQ already calculates the market value of equity on a daily basis as the share price multiplied by the number of ordinary shares that have been issued. Afterwards, we deflate these market capitalization figures to 2009 dollars using the consumer price index. As a final step, we calculate the quarterly average of daily market capitalizations for each firm because the analyses consider variables at quarterly frequency. To cope with the large magnitude of market capitalization values, we compute the natural logarithms of these values before using them in regressions.

The third control variable we use in the model is equity volatility. It is a proxy for asset volatility (firm value volatility) in the Merton (1974) model. We calculate stock return

volatility to represent equity volatility by computing quarterly standard deviations of daily stock returns, multiplying the resulting numbers by the square root of 252 to convert them into annual figures and then further multiplying by 100 to represent them as percentages.

The last two control variables we use in this research are firm fundamentals calculated based on the financial statements of companies. We obtain the data underlying these variables from CapitalIQ. The first variable *levm* is called the market leverage and is used to analyze the effect of leverage. Financial statements of companies are available quarterly. Thus, the market leverage variable is also available on a quarterly basis. We calculate the measure of market leverage as follows:

$$\text{levm} = \frac{\text{short-term debt} + \text{long-term debt}}{\text{market value of equity} + \text{total liabilities}} \quad (5)$$

The second variable *inc/at* represents profitability, and is the ratio of net income to total assets. To calculate the profitability, we collect the net income and total asset figures from CapitalIQ. This ratio is available on a quarterly basis, as is the leverage ratio. The formula for the profitability variable is as follows:

$$\text{inc/at} = \frac{\text{net income or net loss}}{\text{total assets}} \quad (6)$$

The last two variables can be calculated only on a quarterly basis. This is one of the reasons the variables used in the regressions are considered on a quarterly basis.

5.2 Descriptive Statistics

Table I presents summary statistics for the aggregate sample of firm-quarter observations used in the empirical analysis. We start the analysis with 324 firms chosen among nonfinancial companies in North America based on the criteria of whether they have CDS. Once we consider which companies are also quoted on stock exchanges, the number of companies in the sample reduces to 270. The sample period is 50 quarters. The sample contains circa 11,880 firm-quarter observations for each variable covering the period between 2004 and 2016. All variables are winsorized at 1 percent to ensure that results are robust to outliers. All variables in Table I are calculated at a quarterly frequency.

As Table I shows, the firms in the sample are large-capitalization corporations with a mean value of market capitalization equal to 27.9 billion US dollars. Most of the time, only large publicly owned firms have available CDS data. The average yearly stock return is 4.4%, and the average annual CDS spread is 1.6%. These large firms' businesses are profitable on average. The average income/asset ratio is 0.05%.

As to the firms' indebtedness, the average market leverage ratio is 0.44% for all sample firms. A higher mean value of the market leverage in this sample is consistent with the existing literature's finding. Studying all nonfinancial firms in the annual Compustat database between 1965 and 2003, Lemmon et al. (2008) argue that larger firms tend to have higher leverage. The researchers cite a mean market leverage value of 0.32% for all US firms that have at least 20 years of non-missing data in the Compustat database. The firms in this paper's sample on average are larger than those in the cited study's sample because this paper's sample consists of only publicly owned firms.

Table I
Summary Statistics - Quarterly Data

This table presents summary statistics for the main variables used in our analysis. The data extend from January 2004 to June 2016. All variables in this panel are measured at a quarterly frequency.

	mean	sd	p25	median	p75	count
CDS spread	1.590	2.229	0.407	0.770	1.726	12014
Bid-ask spread	0.093	0.102	0.029	0.061	0.111	11881
Amihud illiquidity	11.284	30.184	1.387	3.151	8.478	11881
Turnover ratio	1.043	0.848	0.505	0.788	1.285	11881
Zero-return days	1.007	1.683	0.000	0.000	1.587	12016
Stock return	4.434	66.817	-26.756	10.004	42.706	11881
Volatility	31.786	19.208	19.542	26.351	37.033	11880
Market cap	27935	45226	4716	12604	29461	11881
Market leverage	0.440	0.180	0.305	0.423	0.554	11864
Income\asset	0.050	0.111	0.024	0.054	0.088	11735

Market capitalization is in million figures. All ratios and rates are represented as percentage in annual terms.

Before continuing with the estimation of the model, we first search for multicollinearity between the independent variables. The correlation matrix presented in Table II shows correlations below 0.55 between independent variables. The highest correlations are those of stock return volatility (q_{vol}): its correlations with the bid-ask spread measure (q_{bas}) is 0.536, and that with the turnover ratio measure (q_{trnr}) is 0.537. Evaluating the correlations between different measures of stock liquidity, we observe that their correlations are not higher than 0.50. This finding allows us to note that these four liquidity measures capture different aspects of stock liquidity.

As to the correlations between independent variables and the dependent variable shown in Table II, the highest correlation exists between stock-return volatility and CDS spreads, and is 0.567. The signs of correlations between each of these independent variables and CDS spreads comply with the expectations based on the Merton (1974) model and the literature. For instance, three measures of stock liquidity (bid-ask spread, the Amihud illiquidity, and zero-return days) should have a positive correlation with CDS spreads, as they do in this table. Higher values of these three measures imply lower stock liquidity, which will lead to higher CDS spreads according to the paper's hypothesis. The correlations with CDS spreads of control variables such as stock return and market leverage indeed have an expected signs. However, there is one exception: the turnover ratio measure of stock liquidity. The correlation between the turnover ratio measure and CDS spreads is expected to be negative, but the data here yield a positive correlation. A higher turnover ratio implies higher stock liquidity, which was supposed to lead to lower CDS spreads. In conclusion, the correlation table does not show any major signs of multicollinearity between independent variables that might be of concern statistically.

Table II
Correlation Matrix - Quarterly Data

The table shows the correlations between quarterly observations of CDS spreads (mean_cds), the stock liquidity proxies, and the firm-level control variables. The stock liquidity proxies that we use are: the bid-ask spread (q_bas), the Amihud illiquidity measure (q_illiq), the turnover ratio measure (q_trnvr) and the zero-return days measure (q_zero). The firm-level variables are: stock return (q_r), stock return volatility (q_vol), logarithm of the market capitalization as equity value (q_mcap), market leverage (levm), net income/total assets ratio (inc.at). Data covers the period between January 2004 and June 2013. “q” at the beginning of some variables’ symbol specifies that the frequency of the variables is quarterly. We note that the highest correlation among the four stock (il)liquidity proxies is 0.50 between the bid-ask spread and the Amihud illiquidity measure. Correlations among other variables do not exceed ± 0.57 , indicating that we do not have multicollinearity in the data set.

Variables	mean_cds	q_bas	q_illiq	q_trnvr	q_zero	q_r	q_vol	q_mcap	levm	inc.at
mean_cds	1.000									
q_bas	0.463	1.000								
q_illiq	0.340	0.504	1.000							
q_trnvr	0.409	0.087	0.008	1.000						
q_zero	0.133	0.171	0.096	0.027	1.000					
q_r	-0.098	-0.177	-0.049	-0.125	0.005	1.000				
q_vol	0.567	0.536	0.243	0.537	0.032	-0.318	1.000			
q_mcap	-0.444	-0.390	-0.216	-0.425	-0.192	0.061	-0.449	1.000		
levm	0.505	0.309	0.156	0.389	0.197	-0.085	0.440	-0.590	1.000	
inc.at	-0.265	-0.232	-0.085	-0.215	-0.090	0.133	-0.314	0.288	-0.409	1.000

Furthermore, we analyze the time trends of CDS spreads and stock liquidity by plotting the time series of variables on a chart. Figure 2 depicts the time series of CDS spreads and the bid-ask spread measure of stock liquidity from January 2004 to June 2016. The two series follow each other very closely and exhibit similar trends. Moreover, the increases and decreases in the bid-ask spread are followed by the respective changes of CDS spreads with a time lag. This trend confirms the hypothesis of our research and implies that any changes in liquidity of a firm's stock influence the movements in CDS spreads of the same firm.

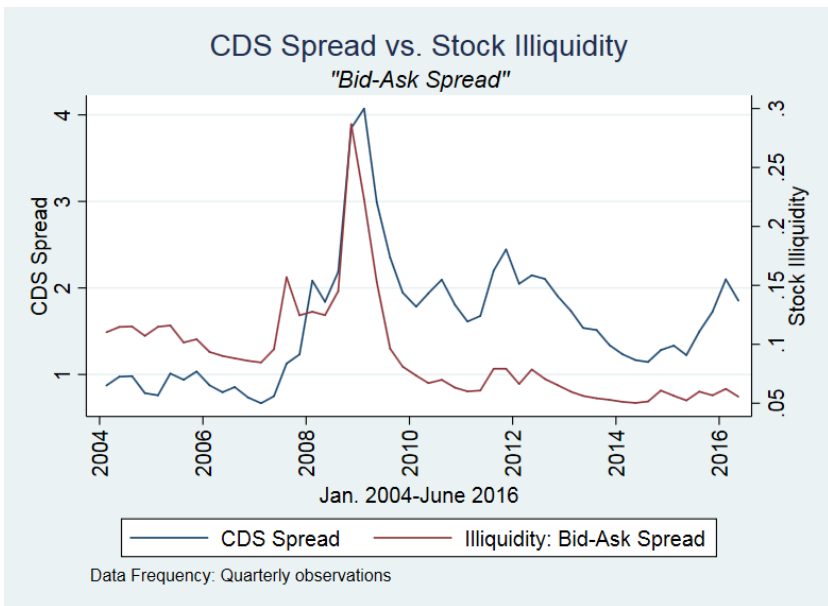


Figure 2: Time Series Analysis of CDS Spread and Stock Illiquidity proxied by Bid-Ask Spread

We also plot the time series of the Amihud illiquidity measure of stock liquidity and CDS spreads in Figure 3. The two series move closely with each other over the time. Although the time lag between the two variables is not as apparent as it is in the first chart, the co-movement of the two series in the same direction is evident and confirms the same intuition as that obtained from the first chart.

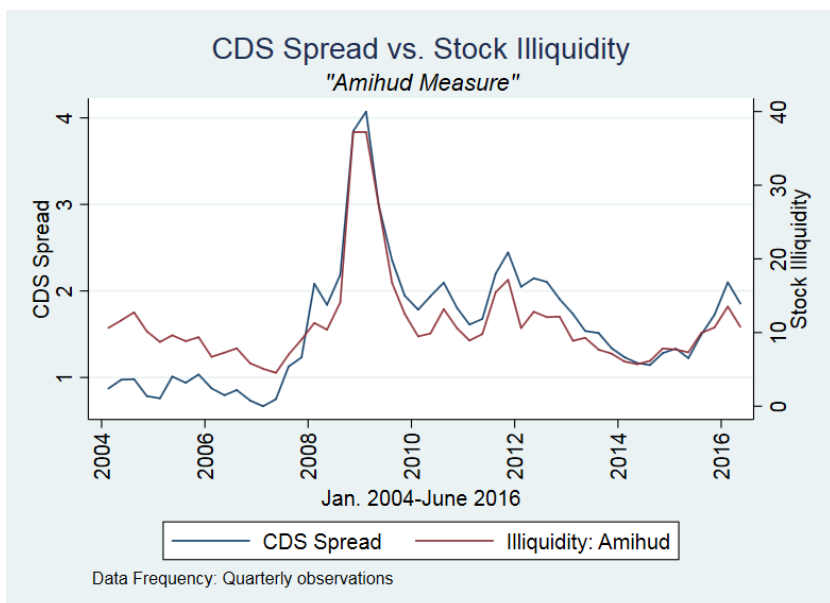


Figure 3: Time Series Analysis of CDS Spread and Stock Illiquidity proxied by Bid-Ask Spread

5.3 Empirical Model

The data are longitudinal (panel) data, whereby we analyze firms from different industries in the cross-sectional dimension over time. Based on the literature, using panel data has some advantages. First, as Kennedy (2009) argues, using panel data allows dealing with heterogeneity in cross-sectional units in each time period, thus coping with the omitted variables problem. Omitting time series variables, which influences the behavior of firm-specific variables, causes bias in the estimation. Second, panel data provides more variability by combining variation across cross-sectional units with variation over time, eliminating any multicollinearity problems to some extent (Kennedy, 2009, 281-282). Third, panel data are more informative than cross-sectional data. Such data enable us to examine how an independent variable behaves across firms over different months and explain its effects on the dependent variable. Fourth, panel data let us perform a better analysis of dynamic adjustments: standalone cross-sectional data are unable to provide us dynamics, whereas we would need very lengthy times-series data to obtain better estimates of dynamic behavior (Kennedy, 2009).

For the empirical model, we use five different regression specifications to explore the influence of stock liquidity on CDS spreads. In all specifications, we calculate t -statistics using robust standard errors that are clustered at firm and quarter levels. We start the firm-quarter analysis with a basic specification where we regress only the main explanatory variable, the stock liquidity measure such as the bid-ask spread, on CDS spreads. The first regression specification is as follows:

$$\text{CDS}_{i,t} = \beta \text{liq}_{i,t-1} + \epsilon_{i,t}, \quad (7)$$

where we denote the CDS spread of a firm i in quarter t by $\text{CDS}_{i,t}$, the stock liquidity of firm i in quarter $t - 1$ by $\text{liq}_{i,t-1}$ and the main coefficient of interest by β , and the residual of firm i in quarter t by $\epsilon_{i,t}$.

We use four proxies for the stock liquidity variable represented above by $\text{liq}_{i,t-1}$. These are the stock illiquidity of firm i in quarter $t - 1$ implied by the bid-ask spread measure and denoted by $\text{q.bas}_{i,t-1}$, the stock illiquidity of firm i in quarter $t - 1$ implied by the Amihud illiquidity measure and denoted by $\text{q.illiq}_{i,t-1}$, the stock liquidity of firm i in quarter $t - 1$

implied by the turnover ratio measure and denoted by q_trnvr , and the stock illiquidity of firm i in quarter $t - 1$ implied by the zero-return days measure and denoted by q_zero .

In the second specification, we introduce all control variables into the regression equation as follows:

$$\begin{aligned} CDS_{i,t} = & \beta liq_{i,t-1} + \gamma^r r_{i,t-1} + \gamma^{vol} vol_{i,t-1} + \gamma^{mcap} mcap_{i,t-1} + \gamma^{levm} levm_{i,t-1} \\ & + \gamma^{inc/at} (inc/at)_{i,t-1} + \epsilon_{i,t} \end{aligned} \quad (8)$$

where we denote the CDS spread of a firm i in quarter t by $CDS_{i,t}$, the stock liquidity of firm i in quarter $t - 1$ by $liq_{i,t-1}$, the main coefficient of interest by β , the quarterly average stock return of firm i in quarter t by $r_{i,t-1}$, the volatility of stock return of firm i in quarter $t - 1$ by $vol_{i,t-1}$, the natural logarithm of market capitalization of firm i as of the previous quarter $t - 1$ by $mcap_{i,t-1}$, the market leverage of firm i in quarter $t - 1$ by $levm_{i,t-1}$, the profitability of firm i in quarter $t - 1$ by $(inc/at)_{i,t-1}$, and the residual of firm i in quarter t by $\epsilon_{i,t}$.

Starting from the third specification, we begin to utilize the fixed effects. In the third specification, we use only firm fixed effects, as shown below. Firm fixed effects remove any time-invariant unobserved characteristics at the firm level.

$$CDS_{i,t} = \beta liq_{i,t-1} + \gamma^{control} X_{i,t-1} + \lambda_i + \epsilon_{i,t}, \quad (9)$$

where $X_{i,t-1}$ represents all control variables, and λ_i is the dummy variable used to control for any firm-specific effects. The other variables are the same as stated before.

In the fourth specification, we use both firm and time fixed effects.

$$CDS_{i,t} = \beta liq_{i,t-1} + \gamma^{control} X_{i,t-1} + \lambda_i + \eta_t + \epsilon_{i,t}, \quad (10)$$

where η_t is the dummy variable to control for time (quarter) fixed effects. The other variables are as stated previously.

In the last specification, we also add industry-by-time fixed effects to the equation below. We control for industry-specific shocks by including a set of industry codes (SIC) interacted with time (quarter) fixed effects to separate the effects of stock liquidity from contemporaneous industry shocks.

$$\text{CDS}_{i,j,t} = \beta \text{bliq}_{i,j,t-1} + \gamma^{\text{control}} X_{i,j,t-1} + \lambda_i + \eta_t + \nu_{j,t} + \epsilon_{i,j,t}, \quad (11)$$

where i and t index firms and quarters, respectively, as before, and j indexes a specific industry to which the firm belongs. Variable $\nu_{j,t}$ is the dummy variable that controls for industry-by-time fixed effects.

6 Empirical Results

This section documents how stock liquidity in the equity market affects firms' CDS spreads. In Section 6.1, we analyze the effect of stock liquidity on CDS spreads by using the bid-ask spread measure. In Section 6.2, we use the Amihud illiquidity measure in regressions. In Section 6.3, we evaluate the relationship between stock liquidity and CDS spreads using the turnover ratio measure. Finally, in Section 6.4, we measure stock illiquidity with the zero-return days measure while analyzing the effect of stock liquidity on CDS spreads.

6.1 Bid-Ask Spread as a Measure of Stock Illiquidity

We first estimate equations (7)-(11) with the bid-ask spread used as the proxy for stock illiquidity and CDS spreads as the dependent variable. Table III presents the respective results.

Column [1] presents results from the output of Equation (7) where CDS spreads are regressed on the bid-ask spread without any firm and time (quarter) fixed effects. The estimated coefficient is 10.56. It is significant at 1 percent confidence level. The positive sign of this estimate is consistent with the prediction that a higher bid-ask spread implying a lower stock liquidity will lead the firm's CDS spread to increase. A one percentage point increase in the bid-ask spread in quarter $t-1$ corresponds to a 10.6 percentage points increase in the CDS spread in quarter t .

Column [2] adds all control variables according to Equation (8). None of the fixed effects are used in this regression. The estimated coefficient of interest is 2.569. It is statistically significant at 1 percent confidence level. The sign of the coefficient does not change and confirms the prediction. The coefficient implies that a one percentage point increase in stock illiquidity proxied by the bid-ask spread in the previous quarter will lead to a 2.6 percentage points increase in the CDS spread in the next quarter.

As to control variables, we obtain the expected sign for each of the variables with their coefficients being significant at 1 percent confidence level; the exception is the firm's profitability, proxied by income/asset ratio. Its statistical significance is 5 percent. Both return and market capitalization that proxies asset value in the Merton (1974) model have negative coefficients, which confirms the theoretical expectation. Furthermore, the income/asset ratio has a negative sign, implying that the higher profitability of a firm leads to a lower CDS spread of the firm. In turn, the coefficients of equity volatility and market leverage have positive signs, consistently with the Merton (1974) model. In terms of economic significance, e.g., if return increases by one percentage point in annual terms, then CDS spread decreases by 0.00236 percentage point on a yearly basis.

Column [3] adds a state of firm fixed effects to control for time-invariant characteristics at the firm level, as shown in Equation (9). The estimated coefficient of interest increases to 3.170. It is still positive and statistically significant at 1 percent level. To illustrate this estimate in economic terms, a one percentage point increase in stock illiquidity in quarter $t - 1$ will lead to a 3.2 percentage points increase in CDS spread in quarter t . As to the coefficients of the control variables, the signs of coefficients do not change, and they are statistically significant at 1 percent confidence level; the exception is the market capitalization's coefficient, which is significant at 5 percent level.

Column [4] adds time (quarter) to the estimation in column [3] to control for time-specific effects as shown in Equation (10). The inclusion of both fixed effects increases the estimated coefficient to 5.576 compared to column [3]. The coefficient is positive and statistically significant at 1 percent level and translates into a 5.6 percentage points increase in CDS spread. The other coefficients still maintain their expected signs, and are all significant at 1 percent confidence level.

Finally, column [5] adds a state of industry-by-time fixed effects to the estimation in column [4] as stated in Equation (11), to further tighten the specifications. As discussed in Section 5.3, these interacting dummy variables allow me to control for contemporaneous shocks at the state-of-industry level. The inclusion of these controls makes the coefficient of the bid-ask spread to increase a little to 5.840. It is positive and significant at 1 percent level. Economically, a one percentage point increase in stock illiquidity leads to a 5.8 percentage points increase in CDS spread in the next quarter. Moreover, the coefficients of all control variables are statistically significant at 1 percent level, and have the expected signs as predicted by the theory.

6.2 Amihud Illiquidity Measure of Stock Illiquidity

In Table IV, we present the effects of stock illiquidity on CDS spreads determined by using the Amihud illiquidity measure. Columns [1]-[5] use the same specifications as in Table III but shows results obtained using the Amihud illiquidity measure instead of the bid-ask spread to measure stock liquidity. In column [1], the coefficient of interest is 0.0393 and statistically significant at 1 percent level. The magnitude of the coefficient decreases if we also regress CDS spread on control variables and start to use fixed effects one-by-one in other specifications. The estimated effect of stock illiquidity on CDS spread shows little variation across specifications [2]-[5], ranging between 0.0143 and 0.0178. Considering fixed effects does not remove the statistical and economic significance of the coefficient. For instance, in column [5], where all fixed effects are used, a one percentage point increase in stock illiquidity of a firm in quarter $t - 1$ leads to 0.02 percentage point increase in the firm's CDS spread in quarter t . All columns suggest that results obtained using the Amihud illiquidity measure also prove that stock illiquidity in the previous quarter is an essential driver of CDS spread in the next fiscal quarter.

Moreover, results for control variables in Table IV, show that the coefficients of all control variables are also both economically and statistically significant in all specifications. For example, based on column [5], if the stock return increases by one percentage point in annual terms in the previous quarter, then CDS spread decreases by 0.0024 percentage point on a yearly basis.

Table III
Quarterly Regressions of CDS on the Bid-Ask Spread

The regressions in this table examine the impact of stock illiquidity proxied by *bid-ask spread* on CDS spreads. The dependent variable in these regressions is CDS spread that is the quarterly mean of daily CDS spreads. In all specifications, the dependent variable CDS spread has a lead of one period (quarter) with respect to all independent variables. Bid-ask spread is the quarterly average of a firm's daily bid-ask spread. Daily bid-ask spread equals to $100 \times |bid - ask| / [(bid + ask)/2]$. Return is the quarterly mean value of daily logarithmic returns. Market capitalization (cap) is the quarterly average of daily market capitalization that is $price \times total\ number\ of\ outstanding\ shares$. Equity volatility is stock return volatility that is the quarterly standard deviation of daily stock returns. Market leverage is the sum of book values of short-term and long term debts divided by market value of assets. Income/asset is the ratio of net income to total asset. In all regressions, *t-statistics* are calculated using robust standard errors that are clustered at firm and quarter level. They are reported in parentheses.

	Dependent Variable: CDS spread				
	(1)	(2)	(3)	(4)	(5)
Bid-ask spread	10.56*** (6.61)	2.569*** (2.84)	3.170*** (3.57)	5.576*** (5.53)	5.840*** (5.76)
Return		-0.00236*** (-4.84)	-0.00242*** (-6.30)	-0.00256*** (-6.66)	-0.00239*** (-5.69)
Market cap		-0.270*** (-5.06)	-0.284** (-2.21)	-0.525*** (-4.39)	-0.578*** (-4.57)
Equity volatility		0.0362*** (5.53)	0.0243*** (4.04)	0.0303*** (9.48)	0.0318*** (9.25)
Market leverage		3.820*** (8.17)	4.715*** (9.70)	2.675*** (5.47)	2.499*** (5.43)
Income/Asset		-5.251** (-2.02)	-6.577*** (-3.96)	-7.257*** (-4.79)	-6.154*** (-3.93)
N. of Obs.	11609	11369	11369	11369	10996
Adj. R-squared	0.253	0.610	0.776	0.813	0.832
Within R-squared	0.253	0.610	0.506	0.453	0.431
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	270	270	270	270	263

***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Table IV
Quarterly Regressions of CDS on the Amihud Illiquidity

The regressions in this table examine the impact of stock illiquidity proxied by *Amihud illiquidity measure* on CDS spreads. The dependent variable in these regressions is CDS spread that is the quarterly mean of daily CDS spreads. In all specifications, the dependent variable CDS spread has a lead of one period (quarter) with respect to all independent variables. Amihud illiquidity is quarterly mean value of daily calculated Amihud illiquidity ratios. Amihud illiquidity is the ratio of absolute stock return to dollar volume [$100 \times |return| / (price \times volume)$] for each day. Return is the quarterly mean value of daily logarithmic returns. Market capitalization (cap) is quarterly average of daily market capitalization that is $price \times total\ number\ of\ outstanding\ shares$. Equity volatility is stock return volatility that is the quarterly standard deviation of daily stock returns. Market leverage is the sum of book values of short-term and long term debts divided by market value of assets. Income/asset is the ratio of net income to total asset. In all regressions, *t-statistics* are calculated using robust standard errors that are clustered at firm and quarter level. They are reported in parentheses.

	Dependent Variable: CDS spread				
	(1)	(2)	(3)	(4)	(5)
Amihud Illiquidity	0.0393*** (7.64)	0.0143*** (4.08)	0.0160*** (5.29)	0.0169*** (6.14)	0.0178*** (6.91)
Return		-0.00250*** (-4.86)	-0.00269*** (-7.28)	-0.00264*** (-7.53)	-0.00239*** (-6.22)
Market cap		-0.184*** (-3.93)	-0.224* (-1.89)	-0.469*** (-3.99)	-0.530*** (-4.07)
Equity volatility		0.0360*** (5.71)	0.0250*** (4.50)	0.0306*** (9.10)	0.0318*** (9.02)
Market leverage		3.733*** (7.79)	4.143*** (9.38)	2.849*** (6.35)	2.650*** (6.02)
Income/Asset		-5.850** (-2.25)	-7.036*** (-4.30)	-7.808*** (-5.21)	-6.892*** (-4.81)
N. of Obs.	11609	11369	11369	11369	10996
Adj. R-squared	0.303	0.626	0.786	0.817	0.835
Within R-squared	0.303	0.626	0.528	0.463	0.443
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	270	270	270	270	263

***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

6.3 Turnover Ratio as a Measure of Stock Liquidity

In Table V, we investigate whether stock liquidity of a firm proxied by the turnover ratio affects the firm's CDS spread in the next period. In the first two columns (columns [1] and [2]), the coefficient of interest is statistically significant at 1 percent level. However, the sign of the estimated coefficient is positive in both specifications. A positive relationship is inconsistent with the theoretical prediction. A higher turnover ratio implies higher stock liquidity, which is hypothesized to lead to a lower CDS spread, yielding a negative coefficient. On the other hand, neither specification considers any fixed effects. Once we use firm fixed effects in column [3], the coefficient's magnitude decreases; however, more importantly, it becomes statistically non-significant. In column [4], if the time fixed effect is added, the coefficient becomes negative as the theory predicts, but it is still insignificant. In column [5], where all fixed effects are used as in Equation (11), the coefficient turns out to be statistically non-significant and is an economically small positive number. In summary, the turnover ratio measuring stock liquidity fails to show a consistent relationship between a firm's stock liquidity and its CDS spread.

As to control variables, all of their coefficients are statistically significant at 1 percent level in all specifications except for profitability proxied by the income/asset ratio, which has a 5 percent statistical significance in column [2]. The results in Table V also suggest that increases in stock return, market capitalization, and profitability lead to decreases in CDS spread in the next quarter as expected theoretically. In turn, equity volatility and market leverage are factors that cause CDS spread to increase in the next quarter.

6.4 Zero-Return Days Measure of Stock Illiquidity

The last measure we utilize is the zero-return days measure. As mentioned earlier, it is the ratio of the number of trading days with zero returns to the total number of trading days in a quarter. Table VI shows the results of regressions using this zero-return days measure as a proxy for stock illiquidity. The first column displays a coefficient of 0.257 of stock illiquidity obtained if CDS spread is regressed on the zero-return days measure. The coefficient is positive, as we expect, and is statistically significant at 1 percent confidence level in column [1]. The same result holds for column [2], although the magnitude of the coefficient decreases to 0.130. Once we use fixed effects in columns [3]-[5], the statistical significance of the coefficient drops to 5 percent confidence level in column [4] and 10 percent confidence

Table V
Quarterly Regressions of CDS on the Turnover Ratio Measure

The regressions in this table examine the impact of stock liquidity proxied by *turnover ratio measure* on CDS spreads. The dependent variable in these regressions is CDS spread that is the quarterly mean of daily CDS spreads. In all specifications, the dependent variable CDS spread has a lead of one period (quarter) with respect to all independent variables. Turnover ratio measure is the quarterly mean value of daily calculated turnover ratios as a percentage. Turnover ratio equals to volume of traded shares divided by total number of outstanding shares. Return is quarterly mean value of daily logarithmic returns. Market capitalization (cap) is quarterly average of daily market capitalization that is *price* $\times$ *total number of outstanding shares*. Equity volatility is stock return volatility that is quarterly standard deviation of daily stock returns. Market leverage is the sum of book values of short-term and long term debts divided by the market value of assets. Income/asset is the ratio of net income to total asset. In all regressions, *t-statistics* are calculated using robust standard errors that are clustered at firm and quarter level. They are reported in parentheses.

	Dependent Variable: CDS spread				
	(1)	(2)	(3)	(4)	(5)
Turnover ratio	1.392*** (11.00)	0.333*** (2.87)	0.150 (1.13)	-0.0483 (-0.32)	0.0112 (0.08)
Return		-0.00267*** (-6.56)	-0.00263*** (-6.94)	-0.00255*** (-6.08)	-0.00233*** (-4.99)
Market cap		-0.270*** (-4.43)	-0.446*** (-3.27)	-0.717*** (-5.09)	-0.741*** (-5.18)
Equity volatility		0.0353*** (6.76)	0.0282*** (5.80)	0.0387*** (7.99)	0.0396*** (8.05)
Market leverage		3.636*** (7.76)	4.280*** (8.75)	3.147*** (6.24)	3.004*** (6.28)
Income/Asset		-6.104** (-2.44)	-7.601*** (-4.58)	-8.140*** (-5.18)	-7.111*** (-4.37)
N. of Obs.	11609	11369	11369	11369	10996
Adj. R-squared	0.301	0.610	0.770	0.799	0.817
Within R-squared	0.301	0.610	0.494	0.412	0.382
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	270	270	270	270	263

***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

level in columns [3] and [5]. However, the magnitude of the coefficient is between 0.0230 and 0.331. This establishes that there is a positive relationship between stock illiquidity and CDS spread. According to column [5], if all fixed effects are considered, a one percentage point increase in zero-return days measure in quarter $t - 1$ leads to 0.023 percentage point increase in CDS spread in quarter t .

As to the control variables, their coefficients confirm the a priori theoretical predictions explained earlier. Accordingly, the coefficients are statistically significant at 1 percent confidence level, except for the profitability’s coefficient in column [2] that is significant at 5 percent confidence level.

7 Quasi-Instrumental Variable Analysis

Next, we perform an instrumental variable analysis to address the endogeneity bias, which is a common problem encountered while analyzing a causal relationship. Contrary to our expectation, investors might use CDS spreads as signals of firm value. Thereby, they can guide their decisions in the equity market based on the credit risk information they aggregate from the CDS market. Accordingly, changes in CDS spreads can affect equity market investors’ willingness to provide liquidity and thus to induce changes in stock liquidity. Alleviating this endogeneity concern requires having an instrumental variable that is uncorrelated with credit risk and CDS spread but highly correlated with stock liquidity. Unfortunately, it is difficult to find such an instrumental variable. Therefore, a proper instrumental variable analysis is not possible. However, we make a partial effort by regressing stock liquidity against any plausible *observable* measure of credit risk and then use the residuals from that regression as our instruments. This analysis is called the “Quasi Instrumental Variable” procedure (Kashyap and Stein, 2000). At this point, we use S&P credit ratings as observable measures of credit risk of firms. We obtain credit ratings from CapitalIQ.

In this quasi-instrumental variable (Quasi IV) analysis, we first convert S&P credit ratings to a numeric scale following Almeida et al. (2017). The credit ratings’ numeric scale is described in the Appendix in Table VIII. In this scale, better ratings translate into higher numeric values, so that AAA is converted to 22, whereas D is converted to 1. Second, we regress each of the stock (il)liquidity measures on firms’ credit ratings contemporaneously by considering firm, time (quarter), and industry-by-time fixed effects. In these first-step

Table VI
Quarterly Regressions of CDS on the Zero-Return Days Measure

The regressions in this table examine the impact of stock illiquidity proxied by *zero-return days measure* on CDS spreads. The dependent variable in these regressions is CDS spread, that is the quarterly mean of daily CDS spreads. In all specifications, the dependent variable CDS spread has a lead of one time period (quarter) with respect to all independent variables. Zero-return days measure is the fraction of trading days with zero return to total number of trading days during a quarter. It is denoted as a percentage. Return is the quarterly mean value of daily logarithmic returns. Market capitalization (cap) is the quarterly average of daily market capitalization that is $price \times total\ number\ of\ outstanding\ shares$. Equity volatility is stock return volatility that is quarterly standard deviation of daily stock returns. Market leverage is the sum of book values of short-term and long-term debts divided by market value of assets. Income/asset is the ratio of net income to total asset. In all regressions, *t-statistics* are calculated using robust standard errors that are clustered at firm and quarter level. They are reported in parentheses.

	Dependent Variable: CDS spread				
	(1)	(2)	(3)	(4)	(5)
Zero-return days	0.257*** (4.25)	0.130*** (4.25)	0.0295* (1.90)	0.0331** (2.36)	0.0230* (1.75)
Return		-0.00248*** (-5.40)	-0.00258*** (-6.96)	-0.00256*** (-6.05)	-0.00234*** (-5.01)
Market cap		-0.290*** (-5.42)	-0.440*** (-3.26)	-0.692*** (-5.21)	-0.734*** (-5.34)
Equity volatility		0.0433*** (7.78)	0.0308*** (6.38)	0.0381*** (10.61)	0.0399*** (10.48)
Market leverage		3.605*** (7.93)	4.359*** (8.95)	3.108*** (6.20)	2.966*** (6.23)
Income/Asset		-5.765** (-2.28)	-7.480*** (-4.48)	-8.097*** (-5.15)	-7.083*** (-4.35)
N. of Obs.	11740	11367	11367	11367	10994
Adj. R-squared	0.036	0.609	0.770	0.800	0.817
Withi R-squared	0.036	0.609	0.493	0.413	0.383
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	270	270	270	270	263

***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

regressions, we calculate t-statistics using robust standard errors that are clustered at the firm and quarter levels. Next, we use the residuals from the first-step regressions as an instrument in the second-step regressions. We regress the CDS spread of the next quarter on the residuals of the current quarter for each of the stock liquidity measures together with the same control variables in the main regression specifications described in Section 5.3. We also lag by one quarter all the control variables compared to the dependent variable of the CDS spread. We use firm, time, and industry-by-time fixed effects in all regressions. Furthermore, we use bootstrapped standard errors since residuals are already estimated quantities from the first-step regressions.

Table VII presents the results of the Quasi-IV analysis. The first-step regressions depicted in Panel A of Table VII suggest that credit rating is negatively correlated with all liquidity measures. The estimated coefficients are statistically significant at 1 percent confidence level. The coefficients of the bid-ask spread, the Amihud illiquidity and the zero-return day measure are negative (as we predicted) because higher values of each of these three measures correspond to lower stock liquidity that is likely to be attributed to a firm with a lower credit rating.

On the other hand, the coefficient of the turnover ratio measure is also negative. Since a higher turnover ratio implies higher stock liquidity, the coefficient should have been positive. However, as noted before, this measure has failed to assess stock liquidity in the main analyses in Section 6.3. The residuals from these regressions do not optimally include the effect of credit risk. Thereby, we purge the endogeneity bias stemming from reverse causality from the estimates in the second-step regressions as much as possible.

As Panel B of Table VII shows, the coefficients of interest are positive and statistically significant at 1 percent level for the bid-ask spread and the Amihud illiquidity measures. They are 4.085 and 0.013, respectively. However, although the sign of the coefficient of residuals of the turnover ratio measure is negative (as we expected theoretically), it is not statistically significant even at 10 percent confidence level. The coefficient of the turnover ratio measure is -0.152 , as shown in column [2] of Table VII for CDS spreads regressed on the residuals of turnover ratio measure. As to the zero-return day measure, we obtain a predicted positive but statistically non-significant coefficient of residuals. When we analyze the coefficients of control variables in each of these four regressions, all the coefficients are

statistically significant at 1 percent confidence level. They have the expected signs, which are consistent with the previous findings in Section 6.

In conclusion, the results from the Quasi-IV analysis that allays the endogeneity bias to some extent strengthen the causal interpretation, namely, that stock liquidity of a firm in the equity market is a factor determining the movement of CDS spread of the same firm in the debt market with the one-quarter lag.

Table VII
Quasi-Instrumental Variable Analysis

This table provides the results obtained from quasi instrumental variable (quasi IV) approach. We regress each of stock illiquidity proxies against any plausible observable measures of credit risk: credit ratings in the 1st step regressions (Panel A). Then, we use these residuals (*Res. Bid-ask Spread*, *Res. Amihud Illiquidity*, *Res. Turnover Measure*, *Res. Zero-return Days*) as instruments in the 2nd step regressions and regress CDS spreads on them together with control variables from the main regressions (Panel A). S&P credit ratings are converted to a numerical scale. For instance AAA is converted as 22, AA+ as 21, BB- as 10, whereas C as 2 and D as 1. Higher numerical value denotes higher credit rating notation. The other variables have the same definitions as they have been used in earlier analyses. The dependent variable, CDS spread, in the 2nd step has a lead of one quarter with respect to the independent variables. All specifications in both steps include quarter and quarter x industry dummies, as well as firm fixed effects. In the 1st step regressions, we calculate *t-statistics* using robust standard errors that are clustered at firm and quarter level, whereas in the second regression, we use bootstrapped standard errors. *t-statistics* are reported in parentheses.

Panel A:				
	1st Step Regressions: Dependent Variable Stock (il)liquidity			
	Bid-ask spread	Amihud	Turnover	Zero-return Day
Credit ratings	-0.0154*** (-6.68)	-4.889*** (-4.19)	-0.116*** (-6.66)	-0.135*** (-5.75)
N. of Obs.	11244	11244	11244	11352
Adj. R-squared	0.778	0.665	0.792	0.266
With R-squared	0.096	0.074	0.085	0.011
Panel B:				
	2nd Step Regressions: Dependent Variable CDS Spread			
	Bid-ask spread	Amihud	Turnover	Zero-return Day
Res. Bid-ask spread	4.085*** (3.91)			
Res. Amihud Illiquidity		0.0134*** (4.47)		
Res. Turnover Measure			-0.152 (-1.10)	
Res. Zero-return Days				0.00846 (0.61)
Return	-0.00234*** (-5.35)	-0.00234*** (-5.73)	-0.00243*** (-5.04)	-0.00240*** (-4.93)
Market cap	-0.641*** (-4.50)	-0.604*** (-4.19)	-0.732*** (-5.04)	-0.706*** (-4.86)
Equity volatility	0.0362*** (10.29)	0.0357*** (10.03)	0.0427*** (9.29)	0.0407*** (10.63)
Market leverage	2.940*** (5.96)	3.013*** (6.24)	3.062*** (6.11)	3.107*** (6.18)
Income/Asset	-6.954*** (-4.29)	-7.448*** (-4.99)	-7.486*** (-4.51)	-7.501*** (-4.50)
N. of Obs.	10746	10746	10746	10744
Adj. R-squared	0.827	0.831	0.821	0.820
Within R-squared	0.411	0.423	0.388	0.386
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Industry x Time FE	Yes	Yes	Yes	Yes
N. of Firms	256	256	256	256

***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

8 Conclusion

The credit market uses information from the stock market because trading in the latter is much larger in volume and more frequent than trading in the former. If a firm's stock is illiquid, the stock price's information content is lower. How will the credit market evaluate stock illiquidity? Stock illiquidity conveys that potential sellers and buyers in the stock market have different information about the firm and cannot agree on a particular stock price that will reflect the firm value. Stock illiquidity should imply that firms with illiquid stocks are associated with a high level of information asymmetry. A high level of information asymmetry about the firm value and the firm's future performance should then be associated with a high firm's credit risk. Therefore, this paper hypothesizes that stock illiquidity leads to a higher credit risk manifesting as a higher CDS spread in the next fiscal quarter.

To test this hypothesis, we use panel data from Capital IQ for large North American corporations. The data consists of 270 firms and spans the period from 2004 to 2016. We use four different types of metrics (namely, the bid-ask spread, the Amihud illiquidity, the turnover ratio, and the zero-return days measure) in measuring stock liquidity because measuring stock liquidity (illiquidity) is a controversial issue in the literature (Amihud, 2000). In particular, different measures account for various aspects of stock liquidity. High stock liquidity is determined by low values of bid-ask spread, Amihud illiquidity, and zero-return days measure, and by a high value of the turnover ratio measure.

The main finding of the paper is that an increased illiquidity of a firm's stock in the equity market leads to an increase in the same firm's CDS spread during the next fiscal quarter. This relationship between stock liquidity and CDS spreads is shown to be robust across all cost-based liquidity measures, i.e., the bid-ask spread, the Amihud illiquidity, and the zero-return days measure. However, we do not observe the same relationship between the turnover ratio measure and the CDS spread. The turnover ratio measure is distinct from the other three measures, as it is a reflective measure. The significant results from the analyses with cost-based measures seem to be more conclusive because the turnover ratio measure relies solely on the volume of shares and ignores transaction costs.

To address reverse causality concerns, we perform an instrumental-variable analysis in which we use credit ratings to separate stock liquidity measures from the effect of credit risk. To the extent possible, we extract credit risk information embedded in stock liquidity

measures. We thus show that even after eliminating credit risk effect from the stock liquidity measures, increased stock illiquidity still raises CDS spreads in the next quarter.

Policy Implications: The results in this study suggest that CDS market investors and other stakeholders (banks, rating agencies, regulators, etc.) in the financial markets can trace and assess credit risk in advance in the equity market through stock illiquidity. Moreover, illiquidity in the stock market is likely to warn financial regulators about any possible financial contagion that might occur in the credit market in the near future.

Weaknesses: One of the shortcomings of this paper is that the sample is limited to large corporations. The reason is that we measure credit risk by CDS spread, and only large corporations have traded CDS. The results might not therefore apply to other public firms that are smaller in size than the considered firms and do not have known CDS spreads.

A second weakness is that the paper does not adequately address the reverse causality concerns. Utilizing an instrumental variable analysis to deal with these concerns requires finding a valid instrument that induces changes in stock illiquidity (the explanatory variable) but has no independent effect on the CDS spread (the dependent variable). Since both variables depend on credit risk, it is difficult to find such an instrument. Due to the lack of a potential instrument, we perform quasi-instrumental variable analysis where we utilize credit ratings.

Future Research: An interesting topic to be explored in the future would be to extend the analysis to a set of firms that are smaller but nonetheless publicly quoted. However, doing so would require measuring credit risk via another measure that is distinct from the CDS spread since CDS are traded only on very large and established firms.

It would also be interesting to examine whether changes in the CDS spread are more responsive to changes in the stock illiquidity for some specific types of firms or firms in certain industries. For instance, a possible research question will be whether CDS spreads of firms operating in more competitive industries are more responsive to changes in the stock illiquidity than are those of firms in less competitive industries.

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Appendix

Table VIII
Creditor Ratings Numerical Scale

This table presents the conversion S&P credit rating notation to a numerical scale according to the study of Almeida et al. (2017).

Numerical Rating: S&P Rating	
22	AAA
21	AA+
20	AA
19	AA-
18	A+
17	A
16	A-
15	BBB+
14	BBB
13	BBB-
12	BB+
11	BB
10	BB-
9	B+
8	B
7	B-
6	CCC+
5	CCC
4	CCC-
3	CC
2	C
1	SD/D

Table IX
Correlation Matrix - Monthly Data

The table shows the correlations between monthly observations of the CDS spreads (mean_cds), the stock liquidity proxies, and the firm-level control variables. The stock liquidity proxies that we use are: the bid-ask spread (m_bas), the Amihud illiquidity measure (m_illiq), the turnover ratio measure (m_trnvr) and the zero-return days measure (.zero). The firm-level variables are: stock return (m_r), stock return volatility (m_vol), logarithm of the market capitalization as equity value (m_mcap). Data covers the period between January 2004 and June 2013. We note that the highest correlation among the four stock (il)liquidity proxies is 0.46 between the bid-ask spread and the Amihud illiquidity measure. Correlations among other variables do not exceed ± 0.52 , indicating that we do not have multicollinearity in the data set while we do the analyses at the monthly frequency.

Variables	mean_cds	m_bas	m_illiq	m_trnvr	m_zero	m_r	m_vol	m_mcap
mean_cds	1.000							
m_bas	0.437	1.000						
m_illiq	0.337	0.460	1.000					
m_trnvr	0.365	0.079	0.007	1.000				
m_zero	0.060	0.101	0.057	0.009	1.000			
m_r	-0.034	-0.094	-0.011	-0.107	0.004	1.000		
m_vol	0.523	0.471	0.220	0.520	-0.007	-0.210	1.000	
m_mcap	-0.441	-0.363	-0.204	-0.391	-0.134	0.038	-0.413	1.000

Table X
Summary Statistics - Monthly Data

This table presents summary statistics for the main variables used in our analysis. The data extend from January 2004 to June 2016. All variables in this panel are measured at the monthly frequency.

	mean	sd	p25	p50	p75	count
CDS spread	1.745	2.568	0.399	0.783	1.884	48124
Bid-ask spread	0.092	0.104	0.029	0.058	0.111	35618
Amihud illiquidity	11.076	29.419	1.333	3.090	8.282	35618
Turnover ratio	1.040	0.872	0.492	0.774	1.277	35618
Zero-return days	0.735	2.120	0.000	0.000	0.000	47819
Stock return	4.329	111.904	-49.382	10.098	66.235	35618
Volatility	30.850	19.948	18.112	25.200	36.489	35609
Market cap	28030	45421	4715	12649	29555	35618

Market capitalization is in million figures. All ratios and rates are depicted in percentage in annual terms.

Table XI
Monthly Regressions of CDS on Bid-Ask Spread

The regressions in this table examine the impact of stock illiquidity proxied by *bid-ask spread* on the CDS spread. The dependent variable in these regressions is CDS spread that is the monthly mean of daily CDS spreads. In all specifications, the dependent variable CDS spread has a lead of one period (month) with respect to all independent variables. Bid-ask spread is monthly average of a firm's daily bid-ask spread. Daily bid-ask spread equals to $100 \times |bid - ask| / [(bid + ask)/2]$. Return is monthly mean value of daily logarithmic returns. Equity volatility is stock return volatility that is monthly standard deviation of daily stock returns. Market capitalization (cap) is monthly average of daily market capitalization that is $price \times total\ number\ of\ outstanding\ shares$. In all regressions, *t-statistics* are calculated using robust standard errors that are clustered at firm and month level. They are reported in parentheses.

	Dependent Variable: CDS spread				
	(1)	(2)	(3)	(4)	(5)
Bid-ask spread	10.82*** (7.00)	3.583*** (3.27)	3.687*** (3.94)	6.646*** (6.93)	6.745*** (7.91)
Return		-0.000754*** (-2.89)	-0.000837*** (-4.35)	-0.000940*** (-5.00)	-0.000981*** (-4.77)
Equity volatility		0.0428*** (9.90)	0.0272*** (9.63)	0.0276*** (11.19)	0.0276*** (11.04)
Market cap		-0.573*** (-9.55)	-1.282*** (-9.91)	-1.141*** (-10.63)	-1.163*** (-9.65)
N. of Obs.	35401	35392	35392	35392	34295
Adj. R-squared	0.251	0.519	0.751	0.791	0.814
Within R-squared	0.251	0.513	0.470	0.417	0.399
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	270	270	270	270	263

***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

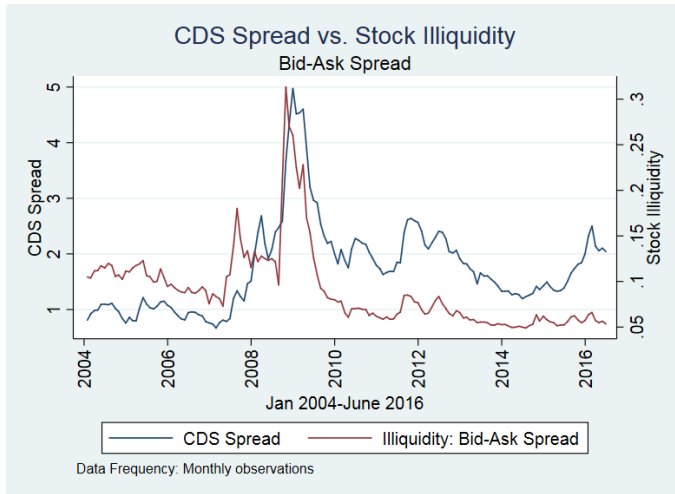


Figure 4: Time Series Analysis of CDS Spread and Stock Illiquidity proxied by Bid-Ask Spread

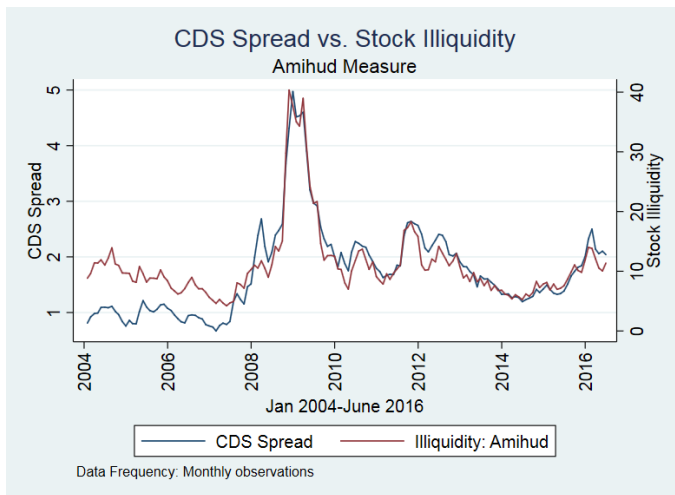


Figure 5: Time Series Analysis of CDS Spread and Stock Illiquidity proxied by Amihud Measure

Table XII
Monthly Regressions of CDS on Amihud Illiquidity

The regressions in this table examine the impact of stock illiquidity proxied by *Amihud illiquidity measure* on the CDS spread. The dependent variable in these regressions is CDS spread that is the monthly mean of daily CDS spreads. In all specifications, the dependent variable CDS spread has a lead of one period (month) with respect to all independent variables. Amihud illiquidity is monthly mean value of daily calculated Amihud illiquidity ratios. Amihud illiquidity is the ratio of absolute stock return to dollar volume [$100 \times |return| / (price \times volume)$] for each day. Return is the monthly mean value of daily logarithmic returns. Equity volatility is stock return volatility that is monthly standard deviation of daily stock returns. Market capitalization (cap) is monthly average of daily market capitalization that is $price \times total\ number\ of\ outstanding\ shares$. In all regressions, *t-statistics* are calculated using robust standard errors that are clustered at firm and month level. They are reported in parentheses.

	Dependent Variable: CDS spread				
	(1)	(2)	(3)	(4)	(5)
Amihud illiquidity	0.0438*** (7.57)	0.0203*** (4.20)	0.0244*** (8.01)	0.0240*** (8.02)	0.0251*** (9.04)
Return		-0.000803*** (-3.42)	-0.000932*** (-5.08)	-0.000916*** (-5.55)	-0.000907*** (-5.06)
Equity volatility		0.0430*** (9.90)	0.0265*** (10.30)	0.0268*** (9.94)	0.0264*** (10.45)
Market cap		-0.448*** (-7.86)	-1.030*** (-8.17)	-1.059*** (-8.91)	-1.085*** (-8.02)
N. of Obs.	35401	35392	35392	35392	34295
Adj. R-squared	0.328	0.546	0.775	0.800	0.823
Within R-squared	0.328	0.546	0.521	0.443	0.430
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	270	270	270	270	263

***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Table XIII
Monthly Regressions of CDS on Turnover Measure

The regressions in this table examine the impact of stock liquidity proxied by *turnover measure* on the CDS spread. The dependent variable in these regressions is CDS spread that is the monthly mean of daily CDS spreads. In all specifications, the dependent variable CDS spread has a lead of one period (month) with respect to all independent variables. Turnover measure is the monthly mean value of daily calculated turnover ratios in percentage. Turnover ratio equals to volume of traded shares divided by total number of outstanding shares. Return is monthly mean value of daily logarithmic returns. Equity volatility is stock return volatility that is monthly standard deviation of daily stock returns. Market capitalization (cap) is monthly average of daily market capitalization that is *price* $\times$ *total number of outstanding shares*. In all regressions, *t-statistics* are calculated using robust standard errors that are clustered at firm and month level. They are reported in parentheses.

	Dependent Variable: CDS spread				
	(1)	(2)	(3)	(4)	(5)
Turnover Measure	1.335*** (11.08)	0.363*** (2.82)	0.0786 (0.69)	-0.0791 (-0.67)	-0.0575 (-0.53)
Return		-0.000911*** (-4.03)	-0.000938*** (-5.00)	-0.000966*** (-4.77)	-0.00100*** (-4.37)
Equity volatility		0.0426*** (9.12)	0.0320*** (8.62)	0.0355*** (8.57)	0.0351*** (8.82)
Market cap		-0.581*** (-8.27)	-1.441*** (-9.59)	-1.488*** (-11.13)	-1.493*** (-10.57)
N. of Obs.	35401	35392	35392	35392	34295
Adj. R-squared	0.268	0.512	0.742	0.768	0.792
Within R-squared	0.268	0.512	0.451	0.354	0.329
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	270	270	270	270	263

***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Table XIV
Monthly Regressions of CDS on Zero-Return Days Measure

The regressions in this table examine the impact of stock illiquidity proxied by *zero-return days measure* on the CDS spread. The dependent variable in these regressions is CDS spread that is the monthly mean of daily CDS spreads. In all specifications, the dependent variable CDS spread has a lead of one period (month) with respect to all independent variables. Zero-return days measure is the fraction of trading days with zero return to total number of trading days during a month. It is denoted in percentage. Return is the monthly mean value of daily logarithmic returns. Equity volatility is stock return volatility that is monthly standard deviation of daily stock returns. Market capitalization (cap) is monthly average of daily market capitalization that is $price \times total\ number\ of\ outstanding\ shares$. In all regressions, *t-statistics* are calculated using robust standard errors that are clustered at firm and quarter level. They are reported in parentheses.

	Dependent Variable: CDS spread				
	(1)	(2)	(3)	(4)	(5)
Zero-return Days	0.133*** (4.27)	0.0953*** (5.14)	0.0237*** (3.50)	0.0237*** (3.71)	0.0189*** (3.76)
Return		-0.000819*** (-3.41)	-0.000918*** (-4.86)	-0.000972*** (-4.72)	-0.00102*** (-4.42)
Equity volatility		0.0508*** (11.82)	0.0335*** (11.38)	0.0344*** (10.43)	0.0345*** (10.66)
Market cap		-0.612*** (-10.06)	-1.429*** (-10.23)	-1.450*** (-11.64)	-1.456*** (-10.81)
N. of Obs.	34972	34970	34970	34970	33853
Adj. R-squared	0.021	0.509	0.742	0.768	0.792
Within R-squared	0.021	0.509	0.450	0.354	0.329
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	270	270	270	270	263

***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Paper III



How Does Debt Composition Influence Credit Risk?

Abstract

How do different types of debt influence firm credit risk? This paper sheds new light on this issue by decomposing the leverage ratio into market debt, bank debt, and trade credit leverage ratios by account type classification; and short-term debt and long-term debt leverage ratios by debt maturity classification. The pecking order theory (Myers & Majluf, 1984) suggests that these debt types differ in terms of the information asymmetry. Therefore, their effects on credit risk might be distinct. We find that debt to financial markets (commercial papers, bonds, etc.) is more positively correlated with the next period's CDS spread than other debt types. CDS spread also reacts positively to bank debt leverage and responds positively to trade credit leverage only for firms in competitive sectors. With regard to maturity classification, the CDS market attributes more credit risk to long-term debt than short-term debt. We also document that the CDS market tracks firms' accounts receivable. Our findings are also robust when we control for the credit quality of firms via credit ratings.

JEL codes: G14, G21, G24, G30, G32, M41

Keywords: Credit Risk, Credit Default Swap, CDS Spread, Capital Structure, Leverage, Information Asymmetry, Credit Ratings, Accounting

1 Introduction

It is a well-known fact that the higher a firm's leverage ratio, the higher its credit risk. However, little is known about how different types of debt affect firms' credit risks. This study aims to fill this gap by addressing the effect of debt composition on credit risk using credit default swaps (CDS). A credit derivative is a contingent claim that enables investors to trade credit risk separately from other sources of uncertainty. Thereby, credit derivatives allow market players to transfer credit risk by facilitating both risk sharing and risk taking. Among credit derivatives, CDS has emerged as the most influential and controversial financial innovation in recent decades. Some impactful studies (e.g., Hull et al., 2004; Longstaff et al., 2005; and Ericsson et al. 2009) examine the determinants of credit risk using CDS spreads and investigate, in particular, how leverage ratio affects credit risk; however, we lack knowledge about how different types of debt affect credit risk.

The determinants of credit risk, particularly credit spread, have been an active research field in recent decades. Most studies have focused on corporate bond spread while examining the determinants of credit risk; a limited number of studies rely on the spread of credit derivatives, which are much younger financial instruments compared to bonds. Credit derivatives make up an important part of financial markets as a trade volume, amounting to trillions of dollars, although there has been a reduction in their trade volume since the global financial crisis that occurred during the period 2007–2008.¹ ² The credit derivatives are traded more frequently than corporate bonds and their spreads are considered a better proxy to measure credit risk (Elton et al., 2001; Blanco et al., 2003; and Ericsson et al., 2009).³ Many credit derivatives have rapidly become an actively traded financial instrument from an exotic niche instrument during the last 20 years.

Since its inception in the early 1990s, the CDS market had grown rapidly until the Great Financial Crisis (GFC), which occurred during the period 2007–2009. However, since the GFC, the CDS market has shrunk in size and undergone a series of structural changes.⁴ The outstanding notional amounts of CDS contracts decreased from USD 61.2 trillion in 2007 to USD 9.5 trillion in 2018. Although there is a decline in its size, the CDS market still has important implications for

¹The total traded notional amount of credit derivative contracts increased to 9.5 trillion dollars in the full year 2018 from 6.8 trillion dollars in the whole of 2017. Source: SwapsInfo Full Year 2018 and Fourth Quarter of 2018 Review, International Swaps and Derivatives Association Inc. (ISDA), January 2019.

²The size of credit default swap (CDS) market is small compared to the total size of all over-the-counter (OTC) derivatives markets. As of the first half of 2018, OTC derivatives notional outstanding was 594.8 trillion dollars. 81% of this was interest rate derivatives (IRD) and only 1.6% was credit derivatives. The rest is foreign exchange derivatives (16%), equity and other derivatives (1.4%). Source: Key Trends in the Size and Composition of OTC Derivatives Markets, ISDA, December 2018.

³The use of credit derivatives has been argued to trigger or deepen a financial crisis (Stulz, 2010).

⁴In the report of the Bank for International Settlements, Aldasoro and Ehlers (2018) classify these changes as the standardization and compression of contracts, new reporting requirements, elimination of redundant contracts, mandatory central clearing, and increased margin requirements.

firms' capital costs, financing choices, and credit risk (Ashcraft et al., 2009; Subrahmanyam et al., 2014; Norden, 2017). In addition, CDSs are used actively as instruments in hedging by investors, funds, and corporations.

The existing literature points out that changes in credit risk may be measured more accurately by CDS spreads rather than by corporate bond yield spreads (Blanco et al., 2003; Ericsson et al., 2009). This is because the CDS spread relies on firm-specific credit risk. In a CDS contract, a protection buyer purchases insurance against a credit event of a pre-specified reference entity from a protection seller. For that protection, the buyer pays a regular premium but the seller commits to compensate the buyer if a credit event occurs (Aldasoro and Ehlers, 2018). A credit event might be bankruptcy, non-payment of debt, and, in some CDS contracts, debt restructuring (Oehmke and Zawadowski, 2017).

The empirical literature examines changes in CDS spread by employing two main types of driving factors: the first group of factors consists of theoretical determinants proposed by structural models of credit risk (e.g., the Merton Model [Merton, 1974]). These variables can be either market based or accounting based. The second group includes solely accounting-based determinants proposed by credit risk models relying on accounting metrics (e.g., Altman's Z-score Model [Altman, 1968] and Ohlson O-score Model [Ohlson, 1980]). These two main branches of credit risk modeling propose one mutual variable: the leverage ratio. In turn, both structural and accounting credit risk models predict that the higher the leverage, the higher the credit risk, and so the higher the CDS spread. Studies analysing the effect of these determinants of CDS spread provide evidence of the effect on the CDS spread of the leverage ratio as a total leverage ratio (Ericsson et al., 2009; Zhang et al., 2009; Galil et al., 2014; Pires et al., 2015).

Examining the debt level of a firm is crucial when evaluating its credit risk. However, it may not only be the debt amount that could affect the credit risk, but also its type. Each debt component has unique features based on the nature of the specific debt contract. According to the pecking order theory (Myers and Majluf, 1984), different types of debt contracts should be associated with different levels of asymmetric information. In particular, investors who have less knowledge of the firm and its industry should face more severe asymmetric information problems. More severe asymmetric information problems should then be associated with higher risk levels. Therefore, we hypothesise that the CDS market attributes a different level of credit risk to each debt component: (i) debt to the financial markets as high risk; (ii) debt to banks as medium risk; and (iii) debt to trade partners as low risk. Regarding maturity division, we hypothesise that debt with longer maturity leads to higher credit risk due to increased information asymmetry over time. To test these hypotheses, we collect daily CDS spread data as a measure of credit risk and financial data

about the firms, as well as their daily stock market data from Capital IQ.

During the empirical exercise, we divide the leverage ratios into two types of classification components. In the first classification, which is by account type, we compute the market debt leverage ratio, the bank debt leverage ratio, the trade credit leverage ratio, and a derivative of the latter, a net-off trade credit leverage ratio. Through the market debt leverage ratio, we measure leverage stemming from a firm's debt to financial markets consisting of commercial papers, bonds, and capital & finance lease obligations. The bank debt leverage ratio gives us leverage, which originates from the firm's indebtedness to banks, whereas the trade credit leverage ratio provides us with how much the firm is leveraged based on its debt to its trade partners, such as suppliers. We also compute the net-off trade credit leverage ratio, for which we analyse the net financial position of a firm, i.e. the firm's borrowing and lending relationships with its suppliers and customers. To do so, we net-off accounts payable with accounts receivable.

In the second classification, which is by maturity, we employ two ratio components: short-term debt leverage and long-term debt leverage. The former leverage ratio measures leverage according to a firm's debt for which the maturity is less than a year; the latter computes leverage based on a debt for which the maturity is more than a year according to accounting standards. We hypothesise that the higher the leverage ratio components, the higher the firm credit riskiness, and, consequently, the higher the CDS spread during the next financial period.

While focusing on leverage ratio and its components, we follow the existing literature and evaluate the explanatory power of other market-based and accounting-based measures as control variables on the CDS spread. We use the market-based variables of stock return, market capitalization, and stock return volatility, which are all proposed by Merton-type structural models (Blanco et al., 2003; Longstaff et al., 2005; Cremers et al., 2008; Zhang et al., 2009). We then add an income/asset ratio as an accounting-based variable suggested for firm profitability by credit risk models using accounting metrics. As a further analysis, we address the endogeneity problem by employing credit ratings as an additional control variable. Moreover, our results regarding the effect of net-off trade credit leverage lead us to conduct a deeper analysis about the effect of trade receivable on CDS spread. For this analysis, we use a ratio of accounts receivable to total assets.

Our first main result shows that changes in all leverage ratio components by account type, except the change in the trade credit leverage ratio, influence the next period's CDS spread statistically and economically at significant levels. As hypothesised, we find that the higher the ratio, the higher the CDS spread during the next period. The market debt leverage ratio is found to be the most influential in terms of economic magnitude on CDS spread among all components.

From the second group of results, we find that both leverage ratio components, by debt maturity, have statistically and economically significant effects on the CDS spread during the next period. In addition, CDS spread reacts almost twice as much to long-term debt leverage as it does with short-term debt leverage. This result confirms the mechanism behind our hypothesis. Long-term debt involves a higher level of information asymmetry since time in a credit relationship raises the information asymmetry level. Thus, the CDS market attributes more credit riskiness to long-term liabilities.

As the results of further analyses, we document that we continue to have the same findings in all leverage ratio components once we control for the credit quality of firms using credit ratings to address endogeneity concerns, arguing that firms with low credit quality will have a higher CDS spread, not due to the leverage itself but due to low creditworthiness. Moreover, although the trade-credit leverage ratio does not have a statistically significant effect on CDS spread neither in its individual analysis with control variables nor when we regress CDS spread on it together with other leverage ratio components, we find that trade credit leverage increases the next period's CDS spread of firms that are operating in more competitive industries.

The remainder of this paper is organised as follows. Section 2 summarises related research, describes the value-added of my paper, and provides a theoretical discussion of why various types of debt may affect credit spread differently, relying on the pecking order theory approach. Section 3 discusses the dependent variable, CDS spread, and its characteristics as well as the explanatory variables and their theoretical relationship to credit risk. Section 4 first describes the data and then provides information about the calculation of variables as well as their descriptive statistics. Section 5 explains the frameworks of the empirical models. Section 6 presents the main empirical results, while Section 7 interprets the results in Section 6 and proposes further analyses. Finally, Section 8 concludes the study.

2 Literature Review and Theoretical Framework

2.1 Literature Review

This study relates to the literature on credit risk in general, and the empirical determinants of credit default swap (CDS) spreads in particular. The empirical work on CDS determinants is scarce and relatively recent compared to research on other financial instruments such as stocks and bonds. Academic studies on credit risk have developed some substantial empirical works focusing on corporate bonds as credit-sensitive instruments. Some of these empirical studies use what are known as reduced-form models to value credit-risky bonds. These models postulate the dynamics of default probabilities exogenously and use market data (e.g., bond yields) to estimate the

parameters needed to value credit-sensitive claims (Duffee, 1999; Duffie, Pedersen and Singleton, 2003). The literature judges these reduced-form models to be successful in practical applications, but ineffective in explaining the theoretical determinants of the prices of these credit-risky securities.

However, a different set of empirical studies (e.g. Collins-Dufresne et al., 2001; Campbell and Taksler, 2003) relies on an alternative and older structural approach. In measuring credit risk, the structural approach uses the founding theoretical models of Black and Scholes (1973) and Merton (1974). This approach links a firm's default risk to the variability in its asset value, following a geometric Brownian motion. In his model, Merton (1974) measures credit risk by relying on information provided by the market price of a stock. He considers a firm's equity and debt as options written on the value of a firm's assets and determines the prices of these derivatives using Black & Scholes (1973) option pricing theory. A firm defaults when the market value of its assets is lower than the value of its debt. The Merton Model (1974) proposes financial leverage, the volatility of the firm's asset, and a risk-free structure as the major determinants of financial stress and default (credit) risk. Although these models are considered to be successful in addressing the qualitatively important features of pricing default risk, they have been less effective in practical applications compared to reduced-form models (Duffee, 1999; Duffie and Singleton, 1999). The literature notes that few studies attempt to price any particular instrument by solely implementing a Merton-type structural model.⁵

Instead of implementing Merton-type structural models in practice, the empirical studies in the finance literature mostly use structural approach as a benchmark to identify the theoretical determinants of credit risk and then employs them as explanatory variables in their regressions rather than inputs to a specific structural model (Collins-Dufresne et al., 2001; Campbell and Taksler, 2003). Collin-Dufresne et al. (2001) argue that the theoretical variables based on the structural approach have modest explanatory power to explain credit spread changes. By using industrial corporation bonds data, they find a single systematic common factor that drives a significant part of the residuals; however, the theoretical variables cannot explain this common systematic factor. Campbell and Taksler (2003) investigate the effects of equity volatility – one of the main determinants of credit risk in the Merton Model (1974) – on corporate bond yields. They conclude that idiosyncratic firm-level volatility is an important determinant in explaining the cross sectional variation in corporate bond spreads. Using corporate bond yields, Avramov et al. (2007) argue that Merton-type structural model variables successfully explain more than 54 percent (67 percent) of the variation in credit-spread changes for medium-grade (low-grade) bonds. Another study that considers corporate bond yields as a measure of credit risk and explains what factors

⁵Jones et al. (1984) argue that even for firms with a simple capital structure, a Merton-type model does not perform better than a naive model assuming zero default risk in pricing investment-grade corporate bonds. Moreover, Eom et al. (2004) show that these models have been plagued by poor performance.

can explain the changes in credit spreads is that of Cremers et al. (2008). They use option-based volatility and jump risk as market-based proxies for the theoretical determinants of credit spreads.⁶

The studies focusing on CDS spreads as a measure of credit risk are even more scarce than those focusing on corporate bond spreads. Few studies analyse both corporate bonds and credit default swaps (Blanco et al., 2003; Longstaff et al., 2005). For instance, Blanco et al. (2003) find that both bond and CDS markets appear to price credit risk equally on average. They also argue that the structural model inspired firm-specific variables (e.g. equity returns and implied volatilities) are more statistically significant and have higher economic importance for CDS prices than for corporate bond spreads.⁷ Longstaff et al. (2005) use the information in CDS to measure the size of the default and non-default components in corporate bond spreads.

The literature most related to this study comprises of papers that either analyse theoretical determinants of CDS spreads with new and broader data sets or search for new determinants that can further explain cross-sectional variation in CDS spreads. Using a data set of bid and offer CDS quotes, Ericsson et al. (2009) investigate the link between theoretical determinants of default risk and actual CDS spreads. They show that firm leverage, volatility, and the riskless interest rate are statistically significant and economically important determinants of CDS spreads. Nevertheless, Ericsson et al. (2009) note that a large fraction of the variation in spread differences is still unexplained. Zhang et al. (2009) enrich a Merton-type structural model with stochastic volatility and jumps.⁸ By employing quantile regressions, Pires et al. (2015) find that CDS premiums are strongly determined by CDS illiquidity costs measured by absolute bid-ask spread while controlling for traditional variables such as historical stock return, volatility, leverage, and profitability.

By analysing new factors such as credit ratings, the literature extends the study of determinants of CDS spread as well as theoretical variables determined through a structural approach. While exploring the link between CDS spreads and bond yields, Hull et al. (2004) also analyse the effect of Moody's rating announcements on the pricing of swaps. By using event study methodology, Norden and Weber (2004) analyse the response of stock and CDS markets to the rating announcements of all three major rating agencies. They conclude that both markets review downgrades by

⁶Cremers et al. (2008) argue that individual options contain forward-looking information about the volatility risk of the firm value, one of the main determinants of credit risk in the Merton Model (1974). They conclude that implied volatilities of individual options contain useful information for credit spreads and perform better than historical volatilities measures when explaining cross-sectional and time-series variations in a panel of corporate bonds.

⁷Blanco et al. (2003) also claim that price discovery occurs mostly in the CDS market and the CDS market Granger causes the bond credit spread for those entities for which the price of credit risk differs between the two markets.

⁸Zhang et al. (2009) show that a large portion of variation in CDS spreads can be explained by intra-day refined measures of historical volatility and jump risk by calculating the volatility and jump risks of individual firms from high-frequency data of stock prices.

all three agencies as well as anticipate rating downgrades. Galil and Soffer (2011) also employ the same methodology and investigate asymmetry in the CDS market's response to rating announcements. They find that the CDS market is more sensitive to negative announcements. In a more recent study, with more extensive samples of credit rating events, Finnerty et al. (2013) find that credit rating upgrades also have a significant effect on CDS spreads even though they are not as well anticipated as downgrades. In a supplementary analysis of their study, Galil et al. (2014) explore the cross-sectional ability of structural model variables and S&P credit ratings to explain CDS spreads. They find that ratings substantially improve the explanation of CDS spreads while controlling for structural model variables.

Management earnings forecast and announcement are other factors analysed by the literature regarding their effects on CDS spreads. Shivakamur et al. (2011) document that the credit market reacts to management earnings forecasts via changes in CDS spreads. They conclude that the reactions to forecast news are even stronger than to actual earnings news. Da Silva (2016) finds that CDS market investors utilise the earnings announcements of industry competitors to assess a obligor's financial situation. He adds that common information that is embedded in the accounting information of industry top firms, which rank high in terms of size, liquidity and credit risk, influences the CDS spreads of their industry peers.

The literature also analyses and emphasises the importance of accounting variables in the measurement of credit risk besides market-based variables proposed by structural models. Some studies rely exclusively on accounting data in credit risk analysis. Pioneering studies from accounting literature investigate the power of accounting ratios to predict a firm's default (Beaver, 1968; Deakin, 1972). Beaver (1968) concludes that default firms and non-default firms differ substantially in terms of the leverage ratio and cash flow metric. By using a discriminant analysis, Deakin (1972) finds that financial ratios can effectively predict firm default as early as three years in advance. In parallel to these studies, in finance literature, Altman (1968) develops his pioneering model called Z-score model that employs a multiple discriminant analysis of accounting ratios to measure financial distress and predict default.⁹ However, some criticism arises about discriminant analysis since this analysis requires restrictive statistical assumptions such as the requirement of normality and the independence of variables (Demirovic et al., 2015). The literature then uses binary choice models such as probit and logit. By employing a logit analysis, Ohlson (1980) develops his O-score model and concludes that firm size, leverage, profitability, and liquidity are significant variables affecting credit risk.

⁹In his work, Altman (1968) includes five accounting variables out of his initial list of 22 variables in the final discriminant function that he refers to as a Z-score model: working capital, retained earnings, EBIT, and market value of shareholders' equity and sales. He scales all of them by total assets except market value of shareholders' equity by book value of total liabilities. Altman's Z-score model concludes that only sales/total assets ratio is insignificant.

As expected, the literature examines whether accounting metrics or market-based determinants of credit risk are more informative (Hillegeist et al., 2004; Demirovic & Thomas, 2007; Agarwal & Taffler, 2008; Demirovic et al., 2015). Hillegeist et al. (2004) document that the distance-to-default (DD) measure of the Merton Model (1974), based on market information, outperforms Altman's Z-score (1968) and Ohlson's O-score (1980) models, which rely on accounting variables. Supporting the earlier study, Demirovic and Thomas (2007) find that Merton's distance-to-default measure is the most significant variable in measuring credit risk when using UK data for which credit ratings proxy credit risk. It is worth noting that they state that accounting variables are incrementally informative once they are added to the distance-to-default model. In a subsequent study, in which they use US data and proxy credit risk via bond credit spread, Demirovic et al. (2015) provide additional empirical evidence that market-based measures of credit risk (e.g. equity volatility and Merton's DD measure) perform better than accounting variables in explaining variations in bond credit spread. However, Agarwal and Taffler (2008) argue that the DD measure and a composite accounting measure based on Altman's Z-score model capture different aspects of bankruptcy risk and, alone, neither are a sufficient metric in measuring credit risk. Das et al. (2009) find that both sources of information, accounting- and market-based information, are complementary in the pricing of CDS contracts.

Some studies focus on so-called macro factors and compare their effects on CDS spread with firm-specific, structural model variables. Galil et al. (2014) investigates the effects on CDS spread of common factors (market risk factors) such as spot interest rate, VIX index as market volatility, and firm-specific variables inspired by structural models such as stock return, stock volatility and leverage by using multivariate regressions for each category of variables separately. They conclude that common market variables still have explanatory power after controlling for firm-specific variables. Das and Hanouna (2009) provide a theoretical link between equity market liquidity and CDS spreads via the hedging mechanism. They document that equity market liquidity is still significant in explaining the changes in CDS spreads while controlling for distance-to-default as a credit variable and three-month treasury rate as a macro-economic variable.

We add to this literature by examining the effect of debt composition on firm credit risk. To the best of our knowledge there are no studies that separate leverage ratio into different components and analyse the effect of each leverage component separately on credit risk regarding CDS spread. Our study is the first to delve deeper into the leverage ratio. It contributes to the research on the determinants of credit risk and CDS spread as well as the optimal debt structure from a credit risk perspective. In particular, we find that debt to financial markets, namely market debt, increases a firm's credit risk at a statistically significant level and more economically than bank debt and

trade credits. The CDS market attributes credit riskiness if a firm has a bank debt that is lower amount than the market debt. However, we do not find any statistically significant relationship between the trade credit leverage ratio and CDS spread for any of the firms in the sample. This result implies that the CDS market may evaluate debt to suppliers more as a signal of a firm's credibility in its product market rather than a liability increasing credit risk. However, we show that this interpretation is valid only for firms that have some market power; this is because for firms in competitive industries, higher trade credit leverage ratio leads to higher CDS spread during the next financial period.

2.2 Theoretical Framework

Firms have various possible sources of financing available such as equity, bank debt, market debt, and trade credits. The pecking order theory (Myers, 1984; Myers and Majluf, 1984) argues that when there is information asymmetry between the informed firm insiders and external investors, the firm follows a preferential order when selecting its sources of financing. The firm first chooses internal resources such as retained earnings, then debt, and, finally, the issuance of new equity. The pecking order theory posits that adverse selection costs drive a firm's financing behaviour (Frank and Goyal, 2003). The theory assumes that internal funds are associated with small adverse selection problems. In turn, equity is subject to a severe adverse selection problem, while debt is associated with a medium adverse selection problem. Therefore, when internal funds are not available, the firm prefers debt to equity because there is a lower information cost associated with debt issues.

Depending on the degree of information asymmetry associated with the borrowing relationship, firms also rank different types of debt. Firms first rely on types of debt that have a lower cost. Firms have two main non-market alternatives: trade finance and bank debt finance. Among these two sources of funds, information asymmetry between the parties should be lower in trade finance. The suppliers have some advantages over financial institution lenders in accessing the creditworthiness of their clients, monitoring and forcing the repayment of the trade credit (Peterson and Rajan, 1997).¹⁰ The lower information asymmetry associated with supplier trade credit makes it less expensive than bank debt for firms (Eliehausen and Wolken, 1993; Nielsen, 2002; Giannetti, Burkart

¹⁰Peterson and Rajan (1997) list three main sources of cost advantage. The first one is the suppliers' advantage in information acquisition. Suppliers usually visit their clients' facilities more often than financial institutions and they can collect similar information at a lower cost during the normal course of business. Furthermore, the size and timing of the buyer's orders and his payment time patterns provide additional information to suppliers in evaluating the buyer's business and its creditworthiness (Emery, 1984). Second, suppliers are more advantaged than other lenders in controlling the buyer. The suppliers may threaten to cut off future supplies in the event of borrower actions that reduce the chances of repayment. In fact, many suppliers support their customers for the sake of future business opportunities. Meltzer (1960) argues that trade credit provides a cushion through which wealthy suppliers insure poorer firms against the consequences of tight money. The third advantage is that if the buyer defaults, suppliers can seize the goods they supply more easily and in better conditions than financial institutions. Suppliers already have a network for selling their goods. Therefore, their costs of repossessing and resale will be lower than those of a bank.

& Ellingsen, 2011). Moreover, trade credit indebtedness may reduce information asymmetry regarding a firm's creditworthiness for other lenders.¹¹ According to the pecking order theory, after trade credit, firms should prefer bank debt. In their lending relationships with firms, banks have monitoring power that decreases information asymmetry, and they can set up close relationships with their client firms.¹² Besides monitoring, banks have contractual devices that reduce the risk of debt, such as seizing collateral and identifying covenants in debt contracts (Cerqueiro et al., 2016).

Among all debt types, information asymmetry should be the highest for market debt, which consists of bonds and commercial papers, etc. Market debt and bank debt differ with respect to their access to information, their ability to monitor the borrower, their flexibility in resetting debt contract terms, and the cost of renegotiating the contract. Market debt is held by dispersed arm's-length lenders, i.e. bondholders. These investors do not have monitoring power over obligor firms.¹³ They cannot negotiate lending conditions with firms as banks or suppliers do.

Thus, these three different categorical types of debt (market debt, bank debt, and trade credit) differ in terms of the level of information asymmetry involved in the credit relationship as well as the ability of lenders to monitor the credit relationship. In line with the pecking order theory, we hypothesise that the higher the information asymmetry associated with the credit relationship, the higher the firm credit risk should be and, therefore, hypothesise that the CDS market attributes a different level of credit risk to each debt component: (i) debt to the financial markets as high risk; (ii) debt to banks as medium risk; and (iii) debt to trade partners as low risk. Regarding maturity division, we hypothesise that debt with longer maturity leads to higher credit risk due to increased information asymmetry over time.

3 Description of Variables

3.1 Dependent Variable: CDS Spread

We use CDS spread as a measure for credit risk. A CDS spread can be defined as the periodic rate that a protection buyer pays on the notional amount to a protection seller for transferring the risk of a credit event related to the firm or financial instrument (i.e. bond) that the CDS contract is written on. It is a financial swap agreement that protects the buyer against the default risk

¹¹Burkart and Ellingsen (2004) argue that the incidence of supplier trade credit is a significant signal of the trust of suppliers towards the firm and, thus, may help firms to obtain more bank credit.

¹²Literature in banking provides both theoretical reasoning and empirical evidence and through relationship lending, banks can resolve agency problems and informational asymmetries (Boot and Thakor, 1994; Ongena and Smith, 2000; Degryse and Ongena, 2002). The duration of a bank-firm relationship, creditor concentration, and the number of contractual devices (i.e. collateral, covenant) used are influential factors determining the creditworthiness of a firm (Berger and Udell, 1990; Ongena and Smith, 2000 & 2001; Berger et al., 2011).

¹³Companies are eager and more likely to share their proprietary information with a small group of lenders than with various bondholders (Bhattacharya and Chiesa, 1995).

of the reference firm or instrument. Since CDS contracts are generated by market players, CDS spreads reflect market perceptions about the financial health of the reference firm (Annaert et al., 2013). Market regulatory authorities, institutional traders, and investors interpret changes in CDS spread as signals regarding the financial stability of a firm (Annaert et al., 2013, Norden, 2017). Furthermore, corporate CDS trading is predominantly driven by news and information about the credit risk of a reference firm (Norden, 2017).

Measuring credit risk using CDS spreads rather than corporate bond yield spreads provides important advantages. First, credit default swap contracts are traded more frequently than corporate bonds. Since the introduction of CDS as a new financial instrument, trading in default swap markets has increased substantially although there was some decline after the financial crisis in 2007. The CDS market has become more liquid market throughout the time. It is a known fact that many corporate bonds are rarely traded. In this study, CDS data are collected at a daily frequency. However, most of the studies in the literature that measure credit risk via corporate bond yield spreads use observations each month. Second, CDS spreads convey how the market perceives default risk in comparison with those of a rating agency (Norden, 2017). Blanco et al. (2003) comments that CDS spreads may mirror the changes in the credit quality of the underlying name in the contract more accurately and swiftly than corporate bond yield spreads. Third, CDS spreads are already spreads, so when measuring credit or default risk using CDS spreads, we do not need to determine a risk-free yield curve as a benchmark specification to calculate the spread as we would do in calculating bond yield spreads. Studying bond yield spreads requires the choice of a framework to eliminate coupon effects as well as the choice of a reference risk-free asset, which can be problematic (Ericsson et al., 2009). Fourth, CDS spreads capture both the default and recovery risk aspects of firm distress while being less susceptible to liquidity and tax effects than corporate bond yield spreads (Elton et al., 2001; Das et al., 2009). For instance, Ericsson et al. (2006) shows that there is a significant illiquidity component for corporate bonds, but not for CDS. Therefore, CDS is essentially considered to be a “pure credit” default instrument that offers a less noisy measure of credit risk compared to other debt instruments such as bonds (Callen et al., 2009).

3.2 Main Variables: Leverage Ratio Components

Financial ratios have been widely used in credit risk analysis. Both theoretical and empirical academic studies identify one of them as an essential measure of firm solvency and leverage ratio. Both accounting and economics literature emphasises leverage ratio as an important determinant of credit risk. On the one hand, in his founding work in the accounting literature, Beaver (1966) finds that the leverage and cash flow ratios of non-default firms differ significantly from the ratios of defaulting firms at least five years before failure. On the other hand, in economics literature, Merton (1974) explicitly accounts for leverage in his forward-looking credit risk model and shows

that firm leverage is one of the major determinants of default probability. Following the Merton Model (1974), most academic works use leverage as a determinant of credit risk in their theoretical or empirical frameworks (e.g. Collin-Dufresne et al., 2001; Campbell et al., 2008).

We examine this determinant leverage ratio by analysing its components according to two types of classification. First, we classify leverage according to financial account type. We calculate the leverage ratio components according the classification of the main financial accounts that might exist in every industrial company's balance sheet on the liabilities side. The classification by financial account type can be regarded as a classification of a firm's liabilities according to the lenders. This classification provides us with the knowledge of how firm indebtedness distinctly affects CDS spread regarding from whom the firm borrows. To the extent of data that we obtain from Capital IQ, we compute leverage ratio components from these main financial accounts:

- (i) Financial debt to markets (commercial papers, bonds, capital & finance lease obligations, federal loans, etc.);
- (ii) Financial debt to banks (bank debt);
- (iii) Trade credits (accounts payable);
- (iv) Remaining debt that consists of the liabilities that we do not classify in the first three groups.

After calculating the balances of these accounts, we divide each by the book value of total liabilities plus the market value of equity to compute the respective leverage ratios. We scale all these leverage ratios by the market value of equity rather than the book value of equity as per Campbell et al. (2008) and Frank & Goyal (2009). We name these leverage ratio components, respectively, as follows:

- (i) Market debt leverage ratio;
- (ii) Bank debt leverage ratio;
- (iii) Trade credit leverage ratio;
- (iv) Other leverage ratio.

Furthermore, we calculate the overall leverage ratio, which is simply the ratio of all liabilities to the sum of book value of total liabilities and market value of equity. Frank & Goyal (2009) name this ratio "market leverage" and we call it "total leverage".

The Merton Model (1974) shows, theoretically, that higher leverage implies a shorter distance to the default point and higher default probability. Moreover, empirical studies following Merton's

structural model find that there is a positive relationship between leverage and credit risk and, specifically, CDS spread (Collin-Dufresne et al., 2001; Campbell et al., 2008; Galil et al., 2014). Therefore, we expect a positive relationship between each of these mentioned leverage ratio components and CDS spread, which is the dependent variable.

Regarding the first classification, we also compute one more leverage ratio component that we call "net-off trade credit leverage" ratio, a derivative of the trade credit leverage ratio. Distinct from other debt types, accounts payable (making up trade credit) has its counter account in the asset side of a firm's balance sheet, accounts receivable. These two accounts (accounts payable and accounts receivable) constitute the financial outcomes of the firm's business with its trade partners. It is common for suppliers of a firm to be customers of the same firm. It is a common practice to evaluate these two accounts together in financial statement analysis. Thus, we net-off accounts payable with accounts receivable and then divide that number by the book value of all liabilities plus the market value of equity in the same financial quarter. We believe that the analysis of this ratio is important to summarise the effect of trade finance on CDS spread since the result of netting-off these two accounts indicates whether the firm is a net borrower or net lender in its trade relations. In connection with this analysis, we calculate one more ratio, which is not a leverage ratio: the ratio of accounts receivable to total asset. At this point, we calculate total asset value as the sum of the book value of all liabilities and the market value of equity rather than the book value of asset. We do not use the book value of asset, because, first, we aim to be consistent with the calculation of other ratios in terms of scaling. Second, we prefer to use market values, whenever possible, to obtain the market value of any asset or liability since market prices should reflect all available information according to the Efficient Market Hypothesis (Malkiel and Fama, 1970). Regarding the sign of the link between accounts receivable/total asset ratio and CDS spread, we predict a negative relationship. Although accounts receivable can be considered as a more risky asset compared to some other balance sheet assets such as cash & cash equivalents or property, plant & equipment, it is a part of the asset value of a firm. The higher the accounts receivable, the higher the asset value, and the further away the firm will be from the default point (Merton, 1974).

As a second classification, we classify the leverage according to the maturities of liabilities. In this classification, we compute two leverage ratio components. The first is a short-term debt leverage ratio, which is the ratio of the sum of the liabilities for which maturities are less than a year as of the balance sheet date to the book value of all liabilities plus the market value of equity. The second leverage ratio is the long-term debt leverage ratio, which is the ratio of the sum of the liabilities whose maturities are greater than or equal to one year as of balance sheet date to the book value of all liabilities plus the market value of equity. By doing this classification and computing these two leverage ratio components, we analyse which debt maturity influences the CDS spread the most.

A summary of how we calculate leverage ratio components and the accounts receivable/total asset ratio is presented in Table I:

Table I
Leverage Ratio Components

<i>Measure</i>	<i>Definition</i>
Total leverage	$BVL / (BVL + MVE)$
<i>Components:</i>	
<i>Classification by account type</i>	
Market debt leverage	Non-bank financial debt / $(BVL + MVE)$
Bank debt leverage	Bank Loans / $(BVL + MVE)$
Trade credit leverage	Accounts payable / $(BVL + MVE)$
Net-off trade credit leverage	$(\text{Accounts payable} - \text{Accounts receivable}) / (BVL + MVE)$
Other leverage	Remaining Liabilities / $(BVL + MVE)$
Accounts receivable/total asset	Accounts receivable / $(BVL + MVE)$
<i>Classification by maturity</i>	
Short-term debt leverage	All liabilities with maturities < 1 year / $(BVL + MVE)$
Long-term debt leverage	All liabilities with maturities ≥ 1 year / $(BVL + MVE)$

Notes: BVL stands for book value of liabilities, MVE market value of equity. Market debt is the non-bank financial debt that consists of commercial papers, bonds, capital & finance lease obligations, federal loans, and other short-term & long-term borrowing derivatives.

3.3 Control Variables

In this sub-section, we describe the control variables that we use in every regression model and their theoretical relationships with the CDS spread. In the literature, the variables that are examined as determinants of the CDS spread are classified into two categories: market-based measures and accounting-based measures. The first group relies theoretically on the Merton Model (1974) and considers all of the information reflected in the market price of firms' securities. These are forward-looking measures of credit risk. However, the second group, the accounting-based measures, depends on firms' financial statements; these are backward-looking. Although accounting measures are based on the historical data of financial statements, accounting literature shows that accounting variables have the power to predict firm default in advance (Beaver, 1968; Beaver et al., 2005).

The market-based measures that we use as control variables in this study are stock return, equity value (market capitalisation), and equity volatility (stock return volatility). Besides the market-based measures, we use one accounting-based measure as a control variable: income/asset ratio. We review each of these control variables in detail in the following sub-sections:

Stock return:

The market price of a firm's stock is the first key piece of information that investors and bankers refer to while assessing the creditworthiness of public firms. In his seminal work, Merton (1974) suggests that there is a negative relationship between a firm's market value of equity and its probability of default. A higher stock return increases a firm's equity value. Therefore, higher stock return leads to lower probability of default and lower credit risk. Theoretically, we should expect a lower CDS spread implying a lower credit risk after an increase in the stock return of a firm. In short, a negative relationship is expected between stock return and CDS spreads. In this study, we use logarithmic returns that are calculated based on daily prices.

Equity value:

Firm value is another major explanatory variable on credit risk that takes its grants from the Merton Model (1974). The model deducts the face value of the firm's debt from an estimate of the market value of the firm and then divides this difference by an estimate of the volatility of the firm. Based on this calculation, the model generates a score called distance to default and calculates the probability of default based on this score within the framework of the Black-Scholes option pricing formula (Bharath and Shumway, 2008). In the Merton DD model (1974), the market value of the firm is the total market value of the firm's assets. However, the total asset value of a firm is not readily observable. According to the basic accounting principle that total assets' value is equal to

the sum of the values of total liabilities and equity value, one can simply calculate the market value of a firm as a sum of the market values of the firm's liabilities (debt) and the value of its equity. At this point, while the market value of equity can be obtained from the stock market, reliable data on the market value of firm debt is generally unavailable (Bharath and Shumway, 2008). Since the asset value of a company and market value of debt cannot be observed, Merton (1974) suggests using the equity value as a proxy for the firm's value. Theoretically, higher equity value leads to lower probability of default and, thus, lower credit risk. We expect a negative relationship between the equity value of a firm and its CDS spread. We use daily market capitalisation to measure the equity value of a firm in this study. Also noteworthy about equity value is the fact that it also serves as a control variable for the size effect, cross-sectionally, in the regression analysis. In fact, the firm size itself, is an important accounting-based determinant in measuring credit risk (Altman, 1968; Ohlson, 1980).

Equity volatility:

The third variable we use as a market-based control variable from the Merton Model (1974) is equity volatility proxied by stock return volatility. The model estimates the equity of the firm as a call option on its underlying value with a strike price equal to the face value of the firm's debt and a time-to-maturity of T , whereas debt as the value of a risk-free discount bond minus the value of a put option written on the firm with a strike price is equal to the face value of debt and the time-to-maturity of T (Bharath and Shumway, 2008). The volatility of the underlying asset (firm asset value) is an essential determinant of the value of the default-sensitive security (Ericsson et al., 2009). Both options' values depend on the volatility of the firm's value, which is measured by equity volatility using the Merton Model (1974). Furthermore, by finding a strong positive relationship between equity volatility and corporate bond yields, Campbell and Taksler (2003) even argue that the effect of equity volatility on the cost of corporate borrowing appears to be much higher than that in the explanation given by the standard structural model of Merton (1974). We expect that higher stock volatility will increase the firm's probability of default, thus its credit risk. A higher credit risk will lead to higher CDS spread.

Income/asset ratio:

As an accounting-based measure, we employ one control variable indicating firms' profitability. Firms strengthen their equity base by retaining their net income as retained earnings on their balance sheet unless they distribute all their net income. Higher profitability leads to higher equity value and distances a firm from the default point in the Merton Model (1974). In fact, investors often rely on financial ratios to assess the solvency of firms. One of the main ratios to which the accounting literature refers is the ratio of net income to total assets. In his empirical study of 79 failed firms and 79 non-failed firms, Beaver (1968) argues that the cash flow and net income

ratios have the same highest predictive power to forecast the bankruptcy of a firm. He ranks the debt-asset ratio as the third and the working capital ratio as the poorest predictor of these four financial ratios. Moreover, by testing a sample of 396 bankrupt firms, Barth et al. (1998) find that net income decreases as financial health decreases. They add that net income and book value of equity are the primary summary measures of the income statement and balance sheet, and these two accounts have explanatory power to predict the firms' default in the five years preceding bankruptcy. By using US firm data and measuring credit risk via corporate bond spread, Demirovic et al. (2015) find that profitability is the most informative metric among accounting variables in explaining cross-sectional variations in the credit spread. Therefore, we expect that higher net income to total assets ratio should reduce a firm's credit risk theoretically, and, therefore, its CDS spread.

4 Empirical Methodology

In this section, we first provide general information about the data and the sample of the study. Then, we explain how we calculate variables from the data. Finally, we present descriptive statistics of the variables used in the analyses.

4.1 Data

The data used in this study come from the Capital IQ database. In setting up the initial sample, we select US and Canadian firms that operate in industrial sectors and have single name credit default swaps that refer to contracts of five-year maturity and senior unsecured debt. We exclude financial institutions from the sample since they are subject to different financial reporting standards and their financial statement analyses are distinct from the analyses of industrial firms. In addition, these two groups, industrial firms and financial institutions, have distinct business risks. Furthermore, we exclude utility firms since their businesses and the legal and accounting standards that they are subjected to make them exceptional cases compared to other industry firms. These screenings generate 474 firms. Of these 474 firms, we choose those that are publicly quoted in a stock market. This leaves us with 355 firms. We use credit default swaps referring to a five-year maturity contract and senior unsecured debt, because they have emerged as the benchmark for CDS trading and are the most actively traded CDS contracts (Meng and Gwilym, 2008; Zhang et al., 2009). The data includes mostly US dollar nominated and fewer Canadian dollar nominated CDS names. We only use the US dollar as a currency while downloading the financial statements data from Capital IQ.

We base our study on a sample of 355 firms that are frequently traded in the CDS market. All these firms are also publicly quoted in the stock markets. The sample is comprised of 18,438

firm-quarter observations, spanning the period from January 2003 to December 2017. Of the firms in the sample, 93% (331) are US firms whereas 7% (24) of them are Canadian. In the sample, almost half of the firms operate in the manufacturing industry (46%). The transportation industry follows the manufacturing industry with 17%, the mining industry with 12%, and trade (wholesale and retail) with 12%. More information about the sample is exhibited in Table II as follows:

Table II
Sample information

<i>Industry</i>	No. of Firms	<i>By Industry</i>		
		Perc.	No. of Obs.	Perc.
<u><i>Production Sectors</i></u>				
Mining	42	12%	2118	11%
Construction	11	3%	626	3%
Manufacturing	162	45%	8570	47%
Sub-total:	214	60%	11314	61%
<u><i>Service Sectors</i></u>				
Transportation	59	17%	2956	16%
Wholesale Trade	11	3%	621	3%
Retail Trade	32	9%	1688	9%
Other Services	38	11%	1859	11%
Sub-total:	140	40%	7124	39%
Total	355	100%	18438	100%

Notes: Financial institutions (banks & insurance companies) as well as utility companies are excluded from the sample. The sample consists of 355 companies and 18,438 firm-quarter observations between January 2003 and December 2017.

4.2 Methods in calculating variables

We obtain CDS data on a daily basis from Capital IQ. Capital IQ depicts the CDS spread prices at basis points. We use “CDS spread mid-price” from the data and in the analyses, we convert it into percentage terms because other variables are also used in percentage terms. Although some researches in the literature use the daily frequency of CDS spread in their main analyses, we prefer to use quarterly frequency for CDS spread by averaging daily CDS spread mid prices for each quarter (Ericsson et al., 2009) in the regressions. Quarterly frequency is the more appropriate choice for the analyses in this study, because most of the main explanatory variables come from financial statements and the frequency of the financial data is quarterly.

We obtain data for the main explanatory variables (the leverage ratio components and accounts receivable/total asset ratio) from quarterly financial statements downloaded from Capital IQ. We multiply all these ratios by 100 to depict them in percentage terms.

Regarding the market-based control variables that come from the stock market such as stock return and market capitalisation, we use daily closing stock price data and the number of outstanding share daily data from Capital IQ to calculate these variables, respectively. To compute the variable of a stock return, we first calculate daily logarithmic returns. We then compute the quarter average of these daily returns. As a final step, we multiply these quarter daily averages by 252 to make them yearly return figures and by 100 to depict them in percentage terms before utilising them in the regressions. For market capitalisation as a proxy for equity value, we first multiple daily stock prices by the number of outstanding shares for each day. Second, we take the averages of these daily market capitalisation values for each quarter. We then deflate the quarter averages of market capitalisation to the 2015 dollar using the quarterly consumer price index obtained from the Federal Reserve Bank of St. Louis. Finally, we take a natural logarithm of these market capitalisation values before using them in the regressions because they are large numbers compared to other explanatory variables.

In calculating equity volatility, which is the stock return volatility, we compute the standard deviation of daily stock returns for each firm in each quarter. We convert these volatility numbers into annual terms by multiplying the squared root of 252. We then depict them in percentage terms by multiplying them by 100. Regarding the accounting-based control variable, profitability ratio (net income/total asset), its frequency is quarterly due to the frequency of each company's financial statements. We also multiply this ratio by 100 to represent it in percentage terms.

We use S&P credit ratings in the robust analyses. We download them from Capital IQ on a quarterly basis. Before using them, we first convert these ratings into a numerical scale by following Almeida et al. (2017). In this conversion, a higher grade is represented by a greater numerical value such that AAA is converted to 22, whereas D is converted to 1, as shown in Table XV of the Appendix, Section 8.

4.3 Descriptive statistics

First, we trim all the variables at the upper and lower 0.05-percentiles to remove the effects of outliers before we start our data analysis. Table III reports summary statistics on the dependent variable, CDS spreads (in percentage points), and independent variables (in percentage points for the ratios). The analysis is based on firm-quarter observations. The sample contains circa 14,700 firm-quarter observations for the dependent variable CDS spread and circa 17,700 firm-quarter observations for each of the independent variables except for the S&P credit rating, which has circa 16,600 firm-quarter observations. On average, firms in the sample have a positive CDS spread of 1.75% as well as a positive stock return of 6.5% in annual terms.

As we can see in Table III, according to maturity classification, approximately two-thirds (28%) of sample firms' total market leverage (42.4%) comes from their long-term debt and one-third (14.2%) comes from short-term debt. However, according to account type classification, market debt leverage (18.7%) generates the largest part of total leverage (42.4%). The other leverage category (15.8%) follows it. In turn, trade credit leverage (5.7%) and bank debt leverage (2.1%) constitute smaller parts of the total leverage ratio. Moreover, we can see that some firms do not have bank debt as bank debt leverage ratios for first quartile and second quartile of the sample are zero. Since the sample consists of large North American corporations quoted in the stock exchanges, their indebtedness from the banks is not so high compared to other types of liabilities. The low mean value for bank debt leverage in Table III is evidence of low bank indebtedness of sample firms.

Table IV presents the correlation matrix of all the variables used in the main analyses. Since we have a panel data that has both time series and cross section dimensions, we first calculate the correlation coefficients between the variables for each firm in each quarter. Thereby, we obtain a correlation matrix for each quarter. As a final step, we simply take the average of these matrices across time. In short, the correlation matrix in Table IV is the time series average of the quarterly cross sectional correlation matrices. In regard to the analysis of the matrix, all leverage ratio components are positively correlated with the CDS spread. The total leverage ratio has a correlation coefficient of +0.63 with CDS spread. According account type classification, which consists of market debt leverage, bank debt leverage, trade credit leverage, and other (remaining) leverage, market debt leverage has the highest positive correlation with CDS spread among all leverage ratio components in this classification.

Table III
Summary Statistics

This table presents summary statistics for the main variables used in the analysis. The data extends from January 2003 to December 2017. All variables in this panel are measured at the quarterly frequency and are trimmed at the upper and lower 0.05-percentiles.

	mean	sd	p25	p50	p75	count
CDS Spread	1.746	2.480	0.434	0.816	1.867	14656
Total leverage	42.358	18.768	28.292	40.508	54.082	17709
<i>Leverage ratio components:</i>						
	<i>Account Type Classification</i>					
Market debt leverage	18.685	12.532	9.603	15.948	24.882	17709
Bank debt leverage	2.051	4.921	0.000	0.000	1.179	17709
Trade credit leverage	5.708	5.789	1.975	3.950	7.186	17572
Net-off trade credit lev.	-0.795	4.645	-3.321	-1.023	1.221	17203
Other leverage	15.776	11.477	8.529	13.841	21.080	17572
	<i>Debt Maturity Classification</i>					
Short term leverage	14.235	8.738	7.973	11.867	18.220	17709
Long term leverage	28.043	16.098	15.629	25.503	37.573	17709
<i>Control variables:</i>						
Stock return	6.473	67.229	-25.485	11.153	44.769	17758
Equity volatility	31.698	18.730	19.622	26.614	37.188	17758
Market cap	9.391	1.380	8.432	9.404	10.288	17750
Income/asset	5.344	8.472	2.227	5.387	9.163	17883
S&P Credit Ratings	13.974	3.238	12.000	14.000	16.000	16577
Acc. rec./total asset	6.423	5.359	2.708	4.880	8.661	17339

Notes: Market capitalization is in million figures. All ratios and rates are depicted in percentage in annual terms.

Table IV
Correlation Matrix

The table shows the correlations between the quarterly observations of CDS spread (cds), total leverage (lev), the components of the total leverage ratio, and market & accounting-based measures. All variables are calculated based on quarterly measured values. The variable that proxies credit risk (cfs) is the mean value of daily CDS spreads in a quarter. The components of leverage ratio (lev) are according to account type classification: market debt leverage (mktlev), leverage due to bank debt (banklev), trade credit leverage (tclelev), and leverage stemming from other liabilities other than the first three categories, in short, "other leverage" (rlev). Net-off trade credit leverage (tclelev_net) and accounts receivable/total asset (accr_at) ratios are the ratios used to make more detailed analyses. The leverage ratio components according to debt maturity classification are short-term debt leverage (stlev) and long-term debt leverage (ltlev). However, the market- and accounting-based measures as control variables are stock return (r), stock return volatility (vol), logarithm of the market capitalisation as equity value (mcap), net income/total assets ratio (inc_at), and credit rating depicted in numeric value (cr). Data covers the period between January 2003 and December 2017. We note that CDS has the expected positive correlation with all leverage ratios. Regarding control variables, CDS spread has a negative correlation with stock return (r), market capitalisation (mcap), net income/total asset ratio (inc_at), and credit rating (cr) but positive correlation with stock return volatility (vol) as expected from the theoretical knowledge. However, the accounts rec/total asset ratio has an unexpected positive correlation with CDS spread. It is apparent that since the total leverage ratio (lev) includes all debt types, it is highly correlated with its component ratios. As an alternative source of financing against market debt leverage and bank debt leverage, trade credit leverage (tclelev) is negatively correlated with market debt leverage (mktlev) and bank leverage (banklev) ratios.

Variables	cds	r	vol	mcap	lev	stlev	ltlev	mktlev	banklev	rlev	tclelev	tclelev_net	accr_at	inc_at	cr
cds	1.000														
r	-0.081	1.000													
vol	0.618	-0.130	1.000												
mcap	-0.556	0.051	-0.528	1.000											
lev	0.629	-0.143	0.496	-0.593	1.000										
stlev	0.235	-0.075	0.183	-0.243	0.494	1.000									
ltlev	0.558	-0.120	0.462	-0.542	0.868	0.001	1.000								
mktlev	0.556	-0.118	0.405	-0.579	0.689	-0.020	0.803	1.000							
banklev	0.319	-0.048	0.238	-0.275	0.333	0.067	0.346	0.407	1.000						
rlev	0.190	-0.058	0.170	-0.081	0.498	0.338	0.383	-0.111	-0.312	1.000					
tclelev	0.104	-0.033	0.117	-0.212	0.332	0.767	-0.058	-0.048	-0.003	0.022	1.000				
tclelev_net	0.024	0.012	0.011	0.094	0.070	0.230	-0.053	-0.084	-0.075	-0.025	0.444	1.000			
accr_at	0.090	-0.047	0.116	-0.303	0.296	0.614	-0.011	0.018	0.063	0.055	0.670	-0.349	1.000		
inc_at	-0.327	0.092	-0.286	0.297	-0.444	-0.195	-0.400	-0.353	-0.146	-0.198	-0.111	0.000	-0.119	1.000	
cr	-0.682	0.027	-0.591	0.781	-0.683	-0.236	-0.651	-0.621	-0.375	-0.162	-0.160	-0.003	-0.164	0.336	1.000

In this part, we also investigate the time series trend of dependent variable CDS spread against total leverage ratio and its components by plotting their time series in bivariate figures between the first quarter of 2004 and the last quarter of 2017. We take the cross sectional averages of each variable in their quarterly observations to create these time series.

In Figure 1, both CDS spread and total leverage ratio series follow the same trends. The positive relationship between them is apparent. Moreover, the positive correlation between CDS spread and total leverage ratio is still present, even when we use book value of equity instead of market value of equity when calculating the total leverage ratio. The plot of the CDS spread- and book value-based total leverage ratio is provided in Figure 5 of the Appendix, Section 8. In Figure 2, the same pattern is valid for the relationship between the time series of CDS spread and the first leverage ratio component: market debt leverage ratio. Again, both series follow each other closely. Their spikes and troughs coincide with each other. Regarding the relationship between the time series of bank debt leverage ratio and CDS spread, Figure 3 shows that bank debt leverage has a similar trend to CDS spread but we can argue that its correlation is not as strong as the market debt leverage's or the total leverage's correlation with CDS spread. However, as seen in Figure 4, trade credit leverage ratio's time series does not depict the same trend as the CDS spread. When observing all of the figures, it is clear that the highest spike was during the 2007–2009 financial crises, when the CDS market and corporations were exposed to the most significant financial and economic upheaval since the Great Depression.

We also plot a time series of each control variable against CDS spread in the figures from Figure 6 to Figure 9 in the Appendix, Section 8. Their time series trends provide us with an overall picture supporting the theoretical expectations about the relationship between the CDS spread and each control variable, respectively. Furthermore, as mentioned in earlier sections, we group the liabilities that we cannot classify under three categories of market debt, bank debt, and trade credit. We then make a fourth group from these remaining liabilities and refer to it as 'other leverage'. The plot of the CDS spread against other leverage ratio is presented in Figure 10 in the Appendix, Section 8. It shows the positive but relatively weaker correlation between the time series of the CDS spread and the other leverage ratio.

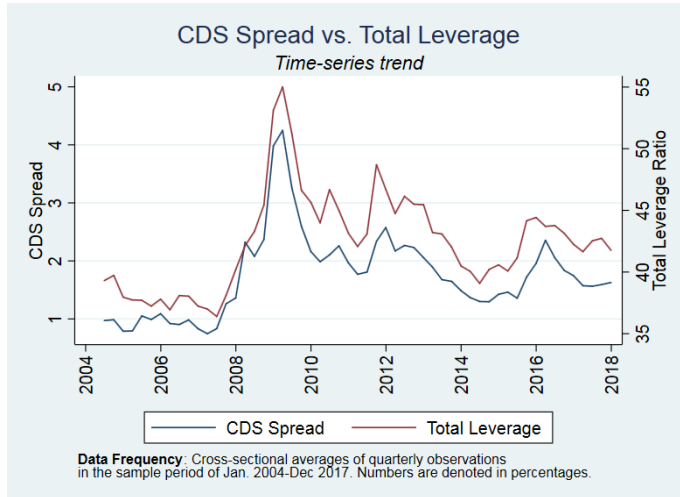


Figure 1: A Time Series Analysis of CDS Spread and Total Leverage Ratio

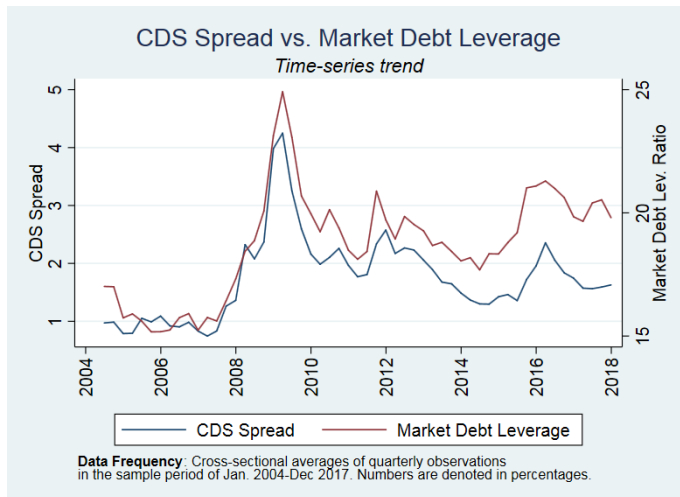


Figure 2: A Time Series Analysis of CDS Spread and Market Debt Leverage Ratio

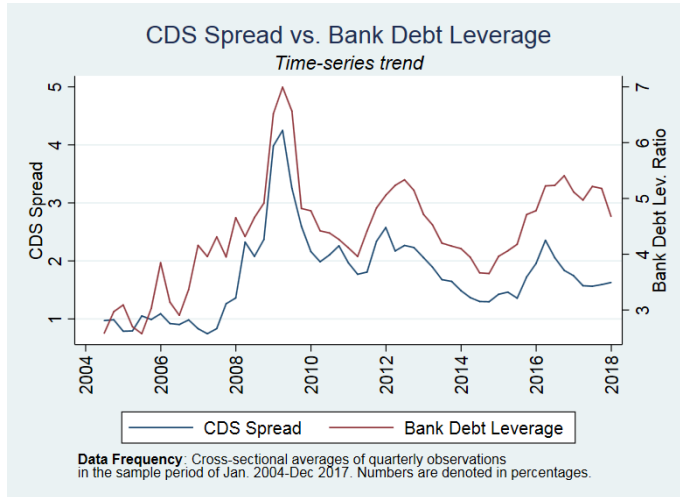


Figure 3: A Time Series Analysis of CDS Spread and Bank Debt Leverage Ratio

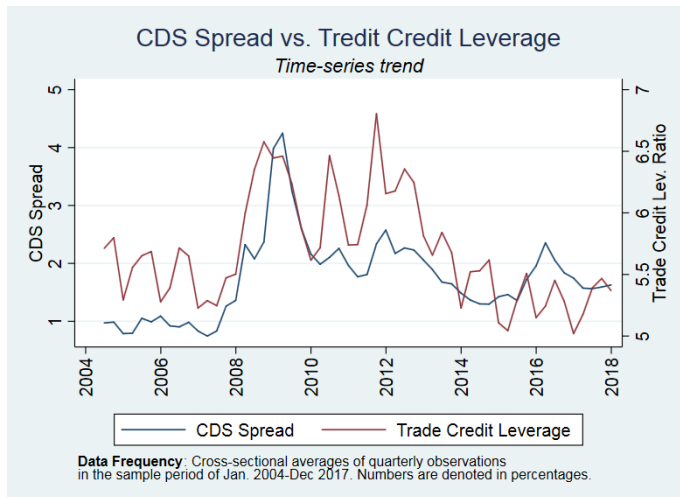


Figure 4: A Time Series Analysis of CDS Spread and Trade Credit Leverage Ratio

5 Empirical Strategy and Models

We use panel data regression methodology to estimate the effects of different components of the leverage ratio, such as market debt leverage ratio or bank debt leverage ratio, on CDS spread. We use five different regression model specifications for every analysis in which we estimate the effect of the specific leverage ratio component or the combined effects of them on CDS spread. In line with our theoretical expectation that the effect goes from our independent variables to the dependent variable, CDS spread always has a lead of one financial quarter with respect to all regressors in all models. This strategy helps us to address the endogeneity concern. Moreover, in all models, we compute t-statistics using robust standard errors that are clustered at firm and quarter levels.

In the first model, we regress CDS spread only on the interest variable, the specific leverage ratio component, and the leverage ratio stemming from the rest of the debt in the firm's liability in its balance sheet. For instance, if the variable of interest is bank debt leverage, we regress the CDS spread on it and its non-bank debt leverage. The second leverage ratio is simply the leverage from all liabilities other than bank debt. The first basic model's specification is as follows:

$$CDS_{i,t} = \beta^c lev_{i,t-1}^c + \beta^{nc} lev_{i,t-1}^{nc} + \epsilon_{i,t} \quad (1)$$

where average CDS spread of a firm i in quarter t is depicted by " $CDS_{i,t}$ "; the specific leverage ratio component of firm i in quarter $t - 1$ by " $lev_{i,t-1}^c$ ", the main coefficient of interest by " β^c "; the leverage ratio of firm i from other remaining debt other than this component in quarter $t - 1$ by " $lev_{i,t-1}^{nc}$ " and its coefficient of " β^{nc} "; and the residual of firm i in quarter t by " $\epsilon_{i,t}$ ".

In this model specification, and in the following ones, the leverage ratio, " $lev_{i,t-1}^c$ ", is one of these specific leverage ratio components through which we quantify a specific component of a company's leverage. For instance, " $mrktlev_{i,t-1}$ " indicates market debt leverage ratio, " $banklev_{i,t-1}$ " bank debt leverage ratio, " $tclev_{i,t-1}$ " trade credit leverage ratio, " $tclev_{i,t-1}^{net}$ " net-off trade credit leverage ratio, " $stlev_{i,t-1}$ " short-term debt leverage ratio, and " $ltlev_{i,t-1}$ " long term debt leverage ratio where i denotes each firm and $t - 1$ denotes each previous financial quarter with respect to the financial quarter of CDS spread. In every regression, we also use the counter leverage ratio for each of these leverage ratio component, for instance, namely non-market debt leverage ratio or non-bank debt leverage ratio, which are denoted by " $non - mrktlev_{i,t-1}$ " or " $non - banklev_{i,t-1}$ " respectively.

We add the control variables to the specification in the second model specification. We use at least four main control variables in all specifications where we use control variables. Three of them

are what we refer as market-based control variables obtained from the stock market data. These are quarterly average of the daily stock returns indicated by “ $r_{i,t-1}$ ”, equity volatility which is the volatility of stock returns in a quarter by “ $vol_{i,t-1}$ ” and equity value that is the average market capitalisation of a firm in each quarter denoted by “ $mcap_{i,t-1}$ ”. The fourth control variable, the ratio of net income to total asset, is an accounting-based measure calculated from quarterly financial statements. We show it as “ $inc/at_{i,t-1}$ ” in the regression specifications. The regression specification for the second model is as follows:

$$CDS_{i,t} = \beta^c lev_{i,t-1}^c + \beta^{nc} lev_{i,t-1}^{nc} + \gamma^r r_{i,t-1} + \gamma^{vol} vol_{i,t-1} + \gamma^{mcap} mcap_{i,t-1} + \gamma^{inc/at} (inc/at)_{i,t-1} + \epsilon_{i,t} \quad (2)$$

In all model specifications, explanatory variables are always used with a lag that is one financial quarter ($t-1$) before the CDS spread’s financial quarter (t) according to the theoretical expectation mentioned above. To further clarify the reasoning for this, investors in the CDS market, bankers, or other stakeholders collect information about the firms from the financial statements and their stock performance in the equity market. Therefore, we assume that both leverage ratio components and control variables influence the CDS spread of each firm with a time lag. This is the best way to address the endogeneity concern based on our theoretical assumption.

One of the benefits that panel data methodology provides is its assumption that firms are heterogeneous. Panel data provides us with more informative data, greater variability and less collinearity between explanatory variables, greater degrees of freedom, and greater efficiency (Baltagi, 2001). However, we still need to check whether there is a correlation between the unobservable heterogeneity $\epsilon_{i,t}$ of each firm, and the models’ explanatory variables. If there is a correlation, we need to use the fixed effects model rather than the random effects model. We use the Hausman (1978) test under the null hypothesis $E(\epsilon_{i,t} | x_{i,t}) = 0$ where $x_{i,t}$ denotes any explanatory variable in Model 1 or Model 2. The Hausman test generates a statistically significant p-value and makes us to reject the null hypothesis that the preferred model is the random effects model. In other words, we opt out of using the random effects model because the effects are considered to be fixed in Model 1 and Model 2. Therefore, we utilise a specification with only firm-fixed effects in Model 3 below:

$$CDS_{i,t} = \beta^c lev_{i,t-1}^c + \beta^{nc} lev_{i,t-1}^{nc} + \gamma^{control} X_{i,t-1} + \lambda_i + \epsilon_{i,t} \quad (3)$$

where $X_{i,t-1}$ depicts all the control variables and λ_i is the dummy variable used to control for any firm-specific effects. Including firm-fixed effects enables us to control for unobserved individual

heterogeneity among firms. In fact, in a study of the determinants of firm leverage, Lemmon et al. (2008) find that leverage contains an important unobserved firm-specific component, which is not fully captured by its own existing determinants proposed by the literature (e.g. firm size, profitability, tangibility, or cash flow volatility). Therefore, we consider that the characteristics of our main explanatory variable, leverage, give us additional reasoning to control for unobserved firm-specific characteristics. The other variables are the same as mentioned earlier.

We explore the effects of the explanatory variables on CDS spread by adding time (quarter) fixed effects to the firm-fixed effects in Model 4:

$$\text{CDS}_{i,t} = \beta^c \text{lev}_{i,t-1}^c + \beta^{nc} \text{lev}_{i,t-1}^{nc} + \gamma^{control} X_{i,t-1} + \lambda_i + \eta_t + \epsilon_{i,t}, \quad (4)$$

where η_t is the dummy variable that captures time (quarter) fixed effects. The other variables are as explained previously.

In this last model, Model 5, we include industry-by-quarter fixed effects to control for the fact that some industry specific characteristics or shocks during a certain time period might interfere with the effects of explanatory variables on the CDS spread. By using industry-by-quarter fixed effects, we assure that the effect is driven only by variation within a given industry quarter. The model's specification is as follows:

$$\text{CDS}_{i,j,t} = \beta^c \text{lev}_{i,j,t-1}^c + \beta^{nc} \text{lev}_{i,j,t-1}^{nc} + \gamma^{control} X_{i,j,t-1} + \lambda_i + \eta_t + \nu_{j,t} + \epsilon_{i,j,t}, \quad (5)$$

where i and t index the firm and the quarter, respectively, as before, and j indexes a specific industry to which the firm belongs. $\nu_{j,t}$ is the dummy variable that controls for industry-by-time fixed effects.

6 Empirical Results

In this section, we present the estimates for the effect of each leverage ratio component on CDS spread starting with the analysis of market debt leverage that emerges, relatively, as the most important leverage ratio component, economically explaining the CDS spread. We then provide the empirical results about the analyses of other leverage ratio components according to account type classification: bank-debt leverage, trade-credit leverage, and net-off trade-credit leverage. Finally, on the CDS spread, we document the estimates for the effects of leverage ratio components according to maturity, namely short-term debt leverage and long-term debt leverage.

Market Debt Leverage Ratio:

Table V provides us with the results of panel regression models when we analyse the effect of the market debt leverage ratio on the CDS spread. In the table, each column presents the estimates in each model specification from Equation 1 to Equation 5. In column [1], the regressors are the explanatory variable of interest, market debt leverage ratio, and its so-called counter leverage ratio – non-market debt leverage ratio – which measures the leverage stemming from other liabilities other than market debt. We do not employ any fixed effects in this specification, nor any other control variables. The estimated coefficient is 0.105 for market debt leverage compared to 0.061, which is the estimated coefficient of non-market debt leverage. Both coefficients are statistically significant at 1 percent confidence level. Theoretically, the signs of both coefficients are positive as we expect: the higher the leverage, the higher the CDS spread. Economically, a 1 percentage point increase in market debt leverage of a firm in a quarter leads to a 0.11 percentage point increase in the CDS spread in the next quarter. Regarding the comparison of coefficients in terms of economic magnitude, we interpret that market debt matters more for CDS spread than other types of debt in a firm’s balance sheet in this basic model, Model 1, since the coefficient of market debt leverage ratio is almost twice that of the coefficient of non-market debt leverage.

In column [2], we add the control variables to the regression specification that is Model 2. These variables are theoretical variables proposed by a structural approach such as stock return, market capitalisation, equity volatility, and income/asset ratio to control for the profitability of each firm. The first three rely on market-based information and the last one on accounting-based information. The estimated coefficient of market debt leverage decreases to 0.062 and the estimated of non-market debt leverage decreases to 0.033. Both coefficients are statistically significant at 1 percent level and their signs are still positive, as expected. A 1 percentage point increase in market debt leverage in a current quarter corresponds to a 0.06 percentage point increase in the CDS spread. All of the estimated coefficients of the control variables have the expected sign from the theoretical perspective at the 1 percent statistical confidence level, although there is a 10 percent confidence level for the stock return. The higher the return, the lower the CDS spread; the higher market cap, the lower the CDS spread; the higher the profitability proxied by income/asset, the lower the CDS spread, whereas the higher the equity volatility, the higher the CDS spread. Once we interpret the control variables’ coefficients economically, all coefficients can be interpreted in percentage points except the one for the market capitalisation. A 1 percent point increase in the market cap leads to a 0.196 basis point increase in CDS spread since market capitalisation as a proxy for equity value is calculated in logarithmic terms.

We run the regression according to Model 3 in column [3], for which we employ only firm-fixed effects. The estimated coefficient of the market debt leverage is 0.062 at the 1 percent statistical

confidence level, twice the coefficient of the non-market debt leverage at 0.031. A 1 percentage point increase in market debt leverage in quarter $t - 1$ implies a 0.06 percentage point increase in the CDS spread in quarter t . The control variables still have their estimated coefficient with the expected signs from the theory at the 1 percent confidence level. In this model, statistical significance for stock return increases to the 1 percent confidence level from 10 percent. Adding firm-fixed effects increases the adjusted R-square from 55.3 % in Model 2 to 76 % in Model 3.

The column [4] present the estimates for the regression that has both firm- and time-fixed effects according to Model 4. The coefficient of market debt leverage is estimated to be 0.051 at the 1 percent confidence level. It is, again, twice the coefficient of the non-market debt leverage, which is 0.023 and statistically significant at the 1 percent confidence level. A 1 percentage point increase in market debt leverage leads to a 0.05 percentage point increase in the CDS spread during the next quarter. The coefficients for the control variables are all statistically significant at the 1 percent confidence level and have the theoretically expected signs. Adding time-fixed effects increases the adjusted R-square from 76 % in Model 3 to 78 % in this model.

The final column in Table V indicates that the estimated coefficient of interest is still statistically significant at the 1 percent confidence level when an industry-by-quarter fixed effect is added to the regression specification as seen in Equation 5. The estimated coefficient of market debt leverage is 0.050, which is almost the same as the previous specification's result. A 1 percentage point increase in market debt leverage in quarter $t - 1$ suggests a 0.05 percentage point increase in CDS spread in quarter t . The estimated coefficients of all control variables remain statistically significant at a 1% confidence level with expected signs at similar magnitudes compared to the previous specification. The adjusted R-square increases up to 80 % in this model, Model 5, for which we employ all three types of fixed effects.

Bank Debt Leverage Ratio:

Table VI presents the results of all five models in analysing the effect of bank debt leverage ratio on CDS spread. Each column in the table reveals the regression result for one of our five models. In column [1], we see the estimated coefficient of bank debt leverage and non-bank debt leverage, which are 0.155 and 0.075, respectively. Both coefficients are statistically significant at the 1 percent confidence level in this basic model, which has neither control variables nor any fixed effects. Once we add the control variables to the regression specification, as seen in column [2], the estimated coefficient of interest drops to 0.103 but it keeps its 1 percent statistical significance level. The coefficient of its counter leverage, non-bank leverage, shares the same trend: it decreases to 0.039 but is also still statistically significant at the 1 percent level. A one-percentage point increase in bank debt leverage suggests a 0.10 percentage point increase in the CDS spread next quarter.

Adding control variables to the specification increases the adjusted R-square from 41% to 56%. The coefficient estimates of all control variables have the hypothesised sign and they are statistically significant at the 1 percent level except for the variable return's coefficient, which has a 5 percent statistical confidence level.

Starting with Model 3, as seen in column [3], we add fixed effects to our analysis one-by-one. Employing a firm-fixed effect makes the estimated coefficient of bank debt leverage decrease to 0.074 but keeps its statistical significance at 1 percent. However, the estimated coefficient of non-bank debt leverage increases a little to 0.049 and is still statistically significant at the 1 percent level. Adding firm-fixed effects does not change the hypothesised signs of the estimated coefficient of control variables. The coefficients' economic magnitudes do not show dramatic change compared to column [2]; however, the statistical significance of the variable return reaches the 1 percent statistical significance level in column [3]. As a final remark, once we add firm-fixed effects to this column, the adjusted R-square increases up to 76%.

The regression results are reported in column [4] when time-fixed effects are also added. The coefficient of bank debt leverage decreases somewhat to 0.061 compared to the previous specification, but it is still statistically significant at the 1 percent level. Moreover, it is still higher (circa 1.6 times bigger) than the estimated coefficient of non-bank debt leverage (0.039), which is also statistically significant at the 1 percent level. The coefficient indicates that there is a positive relationship between bank debt leverage and CDS spread. Economically, a 1 percentage increase in bank debt leverage ratio in quarter $t - 1$ leads to 0.06 percentage points increase in CDS spread in quarter t . Using both firm and time fixed effects does not alter the signs and statistical significance of the estimates of control variables.

On the other hand, the column [5] presents the estimated coefficients once we use Model 5 that contains all fixed effects including industry-by-quarter fixed effects. Bank debt leverage ratio has an estimated coefficient of 0.066 at 1% statistical significance level. It is slightly higher than the previous column's corresponding coefficient. Bank debt leverage influences the next quarter's CDS spread more than non-bank debt leverage. A 1 percentage point increase in the bank debt leverage ratio leads to a 0.07 percentage point increase in CDS spreads during the next quarter. Once we review the estimated coefficients of control variables, their signs and statistical significance levels are the same as previous columns. In addition, there is no dramatic change in the economic magnitudes of their estimated coefficients. As seen in Table VI, column [5], this last specification yields an adjusted R-square of 80%.

Trade Credit Leverage Ratio:

Another component of leverage ratio that we examine is trade credit leverage ratio. Table VII shows the estimates from each regression model in each column. Column [1] presents the basic model specification in which the trade credit leverage ratio and non-trade credit leverage ratio are the only regressors, and neither control variables nor fixed effects are present. The estimated coefficient of the trade credit leverage is 0.043 and is statistically significant at the 1 percent confidence level. However, this coefficient is almost half the magnitude of the estimated coefficient of non-trade credit leverage at 0.087 and is statistically significant at the 1 percent confidence level. Both estimates have the expected sign. The higher each of these leverages, the higher the CDS spread in the next quarter. We note that in previous leverage ratio components' analyses, the estimated coefficient of the variable of interest is always greater than the coefficient of the counter leverage ratio. In fact, once we add the control variables to the regression as seen in column [2], the picture changes: the estimated coefficient of the trade credit leverage is 0.011 and it has the expected positive sign theoretically, but it is no longer statistically significant. However, the non-trade credit leverage ratio's estimate decreases to 0.048 but retains its 1 percent level statistical significance. The control variables have their hypothesised signs: The variables of return, market capitalisation, and income/asset ratio have negative relationship with the next quarter's CDS spread, whereas equity volatility has a negative relationship with the CDS spread in the next quarter as the structural models suggest.

As we do in the analyses of other component ratios earlier, we add firm-fixed effects to the regression specification in column [3], time-fixed effects in column [4], and, finally, industry-by-quarter fixed effects in column [5]. Theoretically, the estimated coefficients of the trade credit leverage ratio are all positive as we expect. However, these coefficients never become statistically significant although other regressors remain statistically significant in all of these models: Model 3, Model 4, and Model 5. The counter leverage ratio of trade credit leverage, non-trade credit leverage, is always positive and statistically significant at the 1 percent confidence level. The higher the leverage other than the trade credit leverage, the higher the CDS spread in the next quarter. For instance, a 1 percentage point increase in non-trade credit leverage in quarter $t - 1$ leads to a 0.04 percentage point increase in the CDS spread in quarter t according to Model 5 in column [5] in Table VII.

The absence of a statistically significant effect of trade credit leverage on the CDS spread takes our attention and leads us to, again, consider the nature of trade credit. Trade credit differs from the other two categories of debt due to its unique features. According to the pecking order theory (Myers and Majluf, 1984), we can classify trade credit as a debt type with the lowest information asymmetry, as discussed in Section 2.2. In support of our hypothesis based on the pecking order

theory's classification of debt with respect to information asymmetry, we predict and find no strong statistical relationship of this debt type with the CSD spread. In turn, rather than as a signal of having higher indebtedness, trade credit might serve as a significant signal of supplier trust and, thus, may be instrumental for obtaining other debt types such as bank loans (Burkart and Ellingsen, 2004). Therefore, we extend our analysis of trade credit leverage in Section 7.4.

Net-off Trade Credit Leverage Ratio:

As seen in the analysis of trade credit leverage's effect on CDS spread, we obtain statistically insignificant estimates. As we are thinking about these results, we aim to investigate this leverage component ratio from another perspective. Generally speaking, trade credit consists of payables due to the trade partners (e.g. suppliers) of a firm. However, an industrial firm also has receivables that are due from its trade partners (e.g. customers). We want to examine the net financial position of a firm with its trade partners and then calculate a leverage ratio based on this figure as mentioned in Section 3.2. Table VIII presents the estimates of this new leverage ratio in all five models in the respective columns. We name this new ratio the "net-off credit leverage ratio", because the numerator of the ratio is the balance of accounts payable minus the balance of accounts receivable in the same quarter; this new balance is then divided by the book value of liabilities plus the market value of equity as we do when calculating other leverage component ratios.

Once we employ the basic model, the estimated coefficient of the net-off trade credit leverage ratio is 0.037 and statistically significant at the 1 percent confidence level as seen in column [1] in Table VIII. As a counter leverage ratio, we still use a non-trade credit leverage ratio as in the analysis of the trade credit leverage ratio. The estimated coefficient of the non-trade leverage ratio is 0.088, which is almost equal to the estimate of the same ratio in the analysis of the trade credit leverage ratio. It is also statistically significant at the 1 percent confidence level. As in column [2], once we add the control variables to the regression specification, the estimate of net-off trade credit leverage ratio almost keeps its magnitude (0.038) and remains statistically significant at the 1 percent level. However, the estimate of the non-trade credit leverage almost halves to 0.049 but also remains statistically significant at 1 percent. The sign of both estimates is positive as we expect, theoretically: the higher the leverage ratio, the higher the CDS spread in the next quarter. At this point, we should note that the sample mean value of net-off credit leverage ratio is negative (-0.795 %), which is less than the mean value of the trade credit leverage ratio (5.708%) as in Table III, since the total balance of accounts receivable for all firms in the sample is higher than their total balance of accounts payable. In other words, generally, firms in the sample are not indebted to their trade partners. The control variables' estimated coefficients in column [2] all have hypothesised signs and are statistically significant at the 1 percent level except the variable return for which the statistical significance is at 5 percent. Using control variables leads to an adjusted R-square of 56% in Model 2.

In column [3], we use firm-fixed effects. The estimated coefficients of both the net-off trade credit leverage ratio and non-trade credit leverage ratio increases in magnitude. They are 0.060 and 0.056, respectively, and statistically significant at the 1 percent level. The control variables' estimated coefficients keep their theoretically expected signs. In the model with firm fixed effects, the statistical significance of variable return also improves to the 1 percent level. In column [4], we add time-fixed effects to the regression specification in Model 4; we obtain the same empirical results in the estimates of all of the variables. The estimated coefficient of the net-off trade credit is still statistically significant with a positive sign. Once we control for any industry-by-quarter fixed effects in column [5], all estimated coefficients are statistically significant and have the expected signs. A 1 percentage point increase in net-off trade credit leverage leads to an increase of 0.06 percentage points in CDS spreads. We have an adjusted R-square of 80% in Model 5 as seen in column [5] of Table VIII.

Combined Analysis of All Components:

We further conduct an analysis in which we use all leverage component ratios as regressors in each model from Model 1 to Model 5. These three components are: market debt leverage ratio, bank debt leverage ratio, and net-off trade credit leverage ratio. Since we have statistically insignificant estimates of the trade credit leverage ratio in its individual analysis, we prefer to use its statistically significant derivative, net-off trade credit leverage ratio, in this combined analysis.¹⁴

Table IX shows the results of the regressions for this combined analysis. In the first column, we only regress leverage ratio components as well as "other leverage ratio", which is the ratio of the remaining debt in the liabilities of a firm divided by the book value of total liabilities and the market value of equity. The estimated coefficients of all leverage ratios are statistically significant at the 1 percent confidence level and are positive as we expect, theoretically. The higher these leverage ratios are, the higher the next quarter's CDS spread. All four variables explain the CDS spread with an adjusted R-square of 42%. According to column [1], bank debt leverage ratio has the highest estimated coefficient in terms of economic magnitude. As usual, in column [2], we add the control variables to the regression specification. Adding control variables causes the adjusted R-square to increase to 57%. However, the estimates of all leverage ratios are still positive and statistically significant at the 1 percent level. The bank debt leverage ratio has the highest estimated coefficient compared to the other three ratios. The control variables also have statistical significance at the 1 percent level (except for the variable return with its significance at the 5 percent level) and hypothesised signs.

¹⁴We perform the same combined analysis with the variable trade-credit leverage ratio. The statistical significance and signs of other leverage component ratios do not change. The results of that analysis can be found in Table XVI in the Appendix, Section 8.

As seen in column [3], once we use firm-fixed effects, the market debt leverage ratio's estimated coefficient (0.059) ranks higher than the bank debt leverage ratio's estimated coefficient (0.044). The former is statistically significant at the 1 percent level, the latter at the 5 percent level. Net-off trade credit leverage and other leverage ratios are still positive and statistically significant at the 1 percent level. The estimated coefficient of the net-off trade credit leverage is higher than the estimated coefficient of the bank debt leverage. In this regression specification, according to Model 3, all control variables have theoretically expected signs and statistical significance at 1% level. The adjusted R-square increases to 76% by adding firm-fixed effects.

We continue the analysis by adding time-fixed effects to the regression specification as seen in column [4] of Table IX. The estimated coefficient of the market debt leverage is 0.050, the highest at the 1 percent statistical significance level. It is followed by net-off trade credit leverage, bank debt leverage, and other leverage ratios. Net-off trade credit leverage and other leverages still have the 1 percent statistical significance in this specification, whereas, surprisingly, the bank debt leverage decreases its statistical significance to the 10 percent level. However, all three ratios have the hypothesised positive signs as the market debt leverage. All the control variables remain statistically significant at 1 percent with their expected signs also in this column. Finally, in column [5], we add the industry-by-quarter fixed effect, in addition to the other two fixed effects. The rank of the leverage ratio components' estimated coefficients does not change in this column. The market debt leverage has the highest coefficient at the 1 percent statistical significance level. A 1 percentage point increase in market debt leverage leads to a 0.05 percentage point increase in the CDS spreads during the next quarter. The result that the market debt has the greatest impact on the CDS spread is consistent with our prediction based on the pecking order theory (Myers and Majluf, 1984), namely that a debt type involving higher information asymmetry leads to higher credit risk. All of the variables, including control variables, have the expected signs. They are all statistically significant at the 1 percent level except for the bank debt leverage for which the statistical significance is 5 percent. We note that its statistical significance improves from the 10 percent level in column [4] to 5 percent in this column. As a last point, the adjusted R-square in the most advanced model, Model 5, becomes 80% as seen in Table IX.

Short-term and Long-term Debt Leverage Ratios:

We also discretise the leverage ratio into components according to the debt maturity as we mentioned in Section 3.2. In this classification by maturity, we have two leverage ratio components: short-term debt leverage and long-term debt leverage ratios. We examine their effects on CDS spread as seen in Table X. Starting from Model 1, we always regress these two leverage ratio components together because they are mutually exclusive parts of the total leverage ratio. In

column [1], both of the leverage ratio components have estimated coefficients that are positive and statistically significant at the 1 percent level. The higher the short-term and long-term debt leverage ratios, the higher the CDS spread during the next quarter. When we compare the magnitudes of the estimated coefficients, the long-term debt leverage ratio has a higher coefficient (0.088) than the short-term debt leverage ratio (0.062). This basic model has an adjusted R-square of 40%.

In column [2] of Table X, once we control for theoretical determinants of the CDS spread as well as the income/asset ratio as a proxy for profitability, the estimates of both leverage ratio components are still positive and statistically significant at the 1 percent level. All variables together in Model 2 explain next quarter's CDS spread with an adjusted R-square of 55%. Long-term debt leverage influences CDS spread more than short-term debt leverage since its estimated coefficient is circa 1.6 times of the short-term debt leverage. The control variables' estimated coefficients have the expected signs. They are statistically significant at the 1 percent level, with the variable return as the only one with a 5 percent statistical significance.

In column [3], we report the corresponding results when we use firm-fixed effects in the regression specification as in Model 3. We obtain similar results in terms of the coefficient's signs and statistical significance compared to the earlier column. One point that we want to document is that the estimated coefficient of the long-term debt leverage ratio becomes more economically significant than the short-term debt leverage ratio. Its coefficient is 0.053 and circa two times the short-term debt leverage's coefficient, 0.026. By using firm-fixed effects, the economic magnitude of all control variables' estimates increases, except the estimate of equity volatility. We note that all of the estimated coefficients of the control variables are statistically significant at the 1 percent level including the variable return's coefficient. We obtain an adjusted R-square of 76% in column [3].

Adding time-fixed effects to the regression specification in column [4] of Table X gives us an estimated coefficient of 0.043 for the long-term debt leverage ratio at the 1 percent statistical significance level and an estimated coefficient of 0.019 for short-term debt leverage ratio at the 5 percent statistical significance level. The gap between these two statistically significant estimates increases. The coefficient of long-term debt leverage is circa 2.3 times the coefficient of the short-term debt leverage. Long-term debt leverage seems to influence next quarter's CDS spread more than the short-term debt leverage. We obtain similar results for the control variables compared to column [3]; their coefficients all show a slight increase in economic magnitude. The adjusted R-square with the use of time-fixed effects increases up to 78%.

The fifth column in Table X reports the results once we use all fixed effects, including industry-

by-quarter fixed effects. All explanatory variables, including control variables, are statistically significant at the 1 percent level estimated coefficient. The coefficient of the long-term debt leverage is 0.042, higher than the coefficient of the short-term debt leverage's coefficient, which is 0.022. The former is almost twice the latter; we see this trend in the previous columns. A one percentage increase in the long-term debt leverage (short-term debt leverage) in quarter $t - 1$ economically implies 0.04 (0.02) percentage points in the CDS spread in quarter t . The signs of the estimated coefficients for the control variables are in line with the theory. Using all three types of fixed effects slightly increases the adjusted R-square to 79%.

To summarise, we have two important findings from this analysis of leverage ratio components according to the debt maturity classification. First, long-term debt leverage influences future CDS spread more than short-term debt leverage. The effect of long-term indebtedness on CDS spread is approximately twice the effect of the short-term indebtedness. This empirical result provides evidence to support our hypothesis: debt with longer maturity increases credit risk more since information asymmetry in the credit relationship increases with maturity. Second, we document that the next quarter spread of a five-year CDS contract is statistically and economically responsive to a firm's short-term debt leverage ratio, which measures the indebtedness within a year.

7 Further Empirical Analyses

We conduct four additional empirical analyses to deepen our understanding about the results that we have obtained in Section 6. In the first part, we examine net-off trade credit leverage ratio in more detail and determine why it has a statistically significant effect on next quarter's CDS spread. In the second part, we calculate the total leverage ratio and its components using the book value of equity rather than the market value of equity unlike the literature. We examine whether the results in Section 6 are still robust once we employ the leverage ratios that are computed purely on accounting data. In the third part, we make the best effort to try to address the endogeneity concern in the relationship between each of these leverage ratio components and the CDS spread. To control for the credit quality of firms on the right-hand side of the regression models, we use another control variable, the credit ratings proposed by the literature (Hull et al., 2004; Norden & Weber, 2004; Finnerty et al., 2013; Galil et al., 2014). In the fourth part, we explore, with thorough analysis grounded on previous literature, why indebtedness from accounts payable do not have an effect on CDS spread as we have found in Section 6; we investigate whether product market concentration has specific implications for the relationship between trade credit leverage ratio and CDS spread.

7.1 The Relationship Between Trade Receivable and CDS Spread:

We have documented two findings in the previous section; trade credit leverage ratio has a statistically insignificant estimate, whereas its derivative ratio, the net-off trade credit leverage ratio, has a statistically significant estimate. We use accounts receivable to net-off accounts payable while calculating the net financial position of each firm in their relationships with their trade partners. In other words, we deduct the accounts receivable balance from the accounts payable balance for each firm in each quarter. Thereby, we compute the net-off trade credit leverage ratio.

In evaluating financial risk and indebtedness of a firm, practitioners, such as bank supervisors, use the method of netting off accounts payable with accounts receivable. We adopt the same methodology when calculating the net-off trade credit leverage ratio. At this point, we have a caveat that it would be better if we had a larger data set showing the maturities of the sub-accounts that make up accounts receivable and accounts payable as well as the classification of these two general accounts, according to customers and suppliers. By having this detailed information, netting off would be more appropriate. Nevertheless, we perform this method using the general balances of accounts receivable and accounts payable, and we calculate the net-off trade credit leverage ratio, which has a statistically and economically significant effect on CDS spread even with other leverage ratio components as seen in Section 6. After that, we consider calculating another ratio, which is the ratio of accounts receivable to the market value of total asset. In calculating the market value of the total asset, we sum the market value of equity and the book value of total liabilities. We name this new variable “trade receivable/asset ratio”. We hypothesise that the higher the trade receivable/asset ratio, the higher the CDS spread during the next period, since accounts receivable is a part of firm asset value. According to the Merton Model (1974), a higher asset value implies being further away from the default point for a firm, which is translated into a lower credit risk and, therefore, a lower CDS spread.

We investigate the effect of trade receivable/asset ratio on CDS spread. Table XI reports the results of the regressions in which the main explanatory variable is a trade receivable/asset ratio. In column [1], we regress this main explanatory variable only with a total leverage ratio. The estimated coefficient of the trade receivable/asset ratio is -0.045 and is statistically significant at the 1 percent level. The sign is negative, as we hypothesise. The higher the trade receivable/asset ratio, the lower the CDS spread next quarter. However, the estimated coefficient of the total leverage ratio is 0.085 and it is statistically significant at the 1 percent level. The higher the total leverage ratio, the higher the CDS spread next quarter. The adjusted R-square in this basic model is 40%. We add the control variables in column [2]; the coefficient of the trade receivable/asset ratio becomes -0.056, which is, economically, more significant in magnitude and it retains its statistical significance at the 1 percent level. The total leverage ratio and control variables have all the

expected signs in their estimated coefficients. All these variables' estimates are statistically significant except the variable of stock return for which the statistical significance is at the 5 percent level. Using control variables in the regression specification increases the adjusted R-square to 56%.

As usual, according to our empirical methodology in Section 5, we employ firm-fixed effects in column [3] of Table XI; we then add time-fixed effects in column [4] to the regression specification, and finally we use all three fixed effects including industry-by-quarter in the last column. The estimated coefficients of the trade receivable/asset ratio are all statistically significant at the 1 percent level in all regression specifications from column [3] to column [5]. It is always negative implying that the higher trade receivable/asset ratio, the lower the CDS spread during the next period. The other explanatory variables also keep their expected signs and statistical significance in all specifications. As seen in column [5] of XI, a one percentage point increase in trade receivable/asset ratio leads to a 0.08 percentage points decrease in the CDS spread during the next quarter. We note that this coefficient is greater than the estimated coefficient of the total leverage ratio in absolute terms.

7.2 Analysis of Accounting Data-based Leverage Ratio Components on CDS Spread:

In the main empirical part of this paper, when calculating the variables of total leverage ratio and its components, first, we prefer to use market data if it is available, just like the finance literature (Campbell et al., 2008; Frank & Goyal 2009; Ericsson et al., 2009). The rationale for doing so is that, first, market data has higher frequency compared to accounting data and it is, thus, more preferable; second, it reflects market opinion considering that we are studying a financial market product, CDS, in our research. Therefore, we have used the market value of equity rather than the book value of equity in the computation of leverage ratios as shown in Table I in Section 3.2.

However, we want to analyse whether the statistical significance of our results regarding the effects of different leverage ratios on next quarter CDS spread stems from using market value of equity in the denominator or not. We investigate whether the leverage ratio components that are calculated purely on book values still have an economically similar and, statistically, the same effect on CDS spread. Therefore, we calculate the total leverage ratio and all of its components by using the book value of equity instead of the market value of equity. To have a general picture, we first examine the time-series trend of dependent variable CDS spreads against the book value-based total leverage ratio that uses the book value of equity. As seen in Figure 11 in the Appendix, Section 8, both series' spikes and troughs follow each other most of the time during the sample period 2004–2017.

Second, we do the regression part for this robust analysis. We only use the most sophisticated empirical model specification in Section 5, Model 5, in all regressions in Table XII. As Model 5 requires, we employ all three fixed effects, all main control variables (stock return, market capitalisation, equity volatility, and income/asset ratio), and robust standard errors clustered at firm and quarter levels in all regressions of this analysis.

Table XII column [1] shows that total leverage ratio, which is calculated totally based on accounting data, has a positive and statistically significant coefficient at the 1 percent level. A 1 percentage point increase in the total leverage ratio in quarter $t - 1$ leads to a 0.015 percentage point increase in the CDS spread in quarter t . All the control variables have the expected signs at the 1 percent statistical significance level confirming their theoretical relationships with CDS spread. The higher the stock return, the market capitalisation, and the income/asset ratio, the lower the CDS spread during the next quarter. The adjusted R-square for this regression is 79 %. In column [2], we regress next quarter's CDS spread on the market debt leverage ratio and its counter leverage ratio (non-market debt leverage ratio), together with control variables. The market debt leverage ratio has a positive and statistically significant coefficient at the 1 percent level, whereas its counter leverage ratio appears to be insignificant. A 1 percentage point increase in the market debt leverage ratio implies a 0.019 percentage point increase in the next quarter of the CDS spread. All control variables have statistically significant coefficients at 1% level with expected signs.

Column [3] of Table XII reports the result of the regression when we regress the CDS spread on the bank debt leverage ratio, which is calculated using the book value of equity. Both bank debt leverage ratio and its counter leverage ratio, non-bank debt leverage ratio, have positive and statistically significant coefficients at the 1 percent level. Their estimated coefficients are 0.035 and 0.036, respectively. In this regression, the estimated coefficients of all of the control variables are also statistically significant at the 1 percent level with the expected signs. In column [4], we analyse the effect of net-off trade credit leverage on CDS spread together with its counter leverage ratio. Net-off trade credit leverage has an estimated coefficient of 0.018 at the 5 percent statistical significance level, which is slightly higher in economic sense than the non-bank debt leverage ratio's estimated coefficient of 0.016 at the 1 percent statistical significance level. The control variables in this regression behave in the same manner as in previous regressions.

In the last column, column [5] of Table XII, we regress the next quarter CDS spread on all leverage ratio components at the same time. Market debt leverage and other leverage ratios have positive estimated coefficients statistically significant at the 1 percent level, whereas bank debt leverage ratio has a positive coefficient statistically significant at the 5 percent level and net-off

trade credit leverage ratio at 10 percent level. In terms of economic magnitude, bank debt leverage ratio has a higher estimated coefficient (0.023) than the market debt leverage ratio (0.019) unlike the results we have had previously. We have the same results for the estimated coefficients of control variables in terms of sign and statistical significance in this regression in which we use all component ratios. As exhibited in the first column of Table XII, in the case of total leverage ratio regression, adjusted R-squares of all regressions, when leverage ratio components are utilised, always emerge as 79% in columns [2] to [5]. To sum up, even if we calculate the leverage ratio and its components with only accounting data that is less frequent than market data on which CDS spread relies, we claim that our main results in Section 6 are still valid. This is clear evidence that CDS market definitely gather and closely analyse financial statements of corporations.

7.3 Controlling for Credit Rating:

One of the most important issues in an empirical work in corporate finance is the endogeneity concern. This also applies to this study. One can argue that the relationship between leverage and CDS spread can be other way around rather than leverage as a determinant of CDS spread. According to this view, once a firm has a bad credit quality, it cannot borrow more so it cannot increase its leverage. Higher credit risk (default risk) may prevent the debt market from lending more to this firm. However, we claim that, at the onset, firms become indebted to maintain their business. Markets then follow and judge their creditworthiness to value any financial instrument tied to the firm's value such as stocks or credit default swap contracts.

In this study, we argue theoretically that leverage is a determining factor for credit risk and, consequently, for CDS spread. CDS contracts can be considered as a pure form of default insurance. Investors or other participants in the credit market try to interpret every piece of information about the credit quality of the firms. The first major source of this information are the financial statements of firms showing how much they are leveraged. The higher the leverage of a firm, the higher the cost for the buyer of the contract per year to buy protection against the firm defaulting on its debt, which simply means a higher CDS spread for investors.

One way to tackle the endogeneity problem is to use one-period lagged explanatory variables, including leverage ratio components, as we have done in structuring the empirical model of Section 5. As a second way to address this endogeneity concern, we consider controlling for the credit quality of firms on the right side of our regression models. We use S&P credit ratings to measure firm credit quality by following the literature (Hull et al., 2004; Norden & Weber, 2004; Finnerty et al., 2013; and Galil et al., 2014). For instance, Galil et al. (2014) conclude that the ratings can explain CDS spreads while using structural factors as other explanatory variables. However they note that during a crisis, credit ratings' predictive power for CDS spreads decreases dramat-

ically, whereas structural model-inspired variables maintain their predictive power relatively well. Another disadvantage of credit ratings is that their frequency is very low. Credit rating agencies neither frequently change their ratings nor frequently publish their evaluation reports about firms. Furthermore, the information from credit ratings can be noisy in terms of timing because many rating agencies release information concerning a potential or actual credit rating change in advance (Finnerty et al., 2013). Furthermore, Hull et al. (2004) find that the CDS market reacts to credit rating changes asymmetrically. They argue that the CDS market responds more to negative credit rating events. Although credit ratings have such drawbacks, the literature lacks measures to control for credit quality other than credit ratings. We think that by controlling for credit quality via credit ratings in our empirical models, we do our best to overcome the endogeneity problem. Here, the endogeneity problem is the reverse causality concern arguing that credit risky firms cannot increase their leverage.

We use S&P credit ratings as an additional regressor in Model 5 for the analysis of each leverage ratio components as well their combined analysis as shown in Table XIII. The first column reveals that market debt leverage ratio is still positive (0.0433) and statistically significant at the 1 percent level after adding the credit rating as a new control variable. The non-market debt leverage ratio is also positive (0.019) and statistically significant at the 1 percent level but it is much smaller in magnitude than the market debt leverage ratio. The estimated coefficient of the credit rating is negative and statistically significant at 1 percent. The negative sign is expected because we convert credit ratings onto a numerical scale and higher numerical values correspond to a better credit rating. Thus, a lower credit rating value implies lower firm credit quality, which leads to a lower CDS spread during the next quarter. The usual control variables of this study are all statistically significant at 1 percent and they keep the expected sign in their estimated coefficients. The adjusted R-square for this regression is 80%.

In column [2] of Table XIII, we run the regression in which the bank debt leverage ratio is the main explanatory variable. The estimated coefficient of the bank debt leverage is 0.051 and statistically significant at the 1 percent level. Its coefficient is also higher than the non-bank leverage ratio's coefficient (0.034), which is also statistically significant at the 1 percent level. There is no change in the sign, economic magnitude, or statistical significance of credit rating in analysing its effect on next quarter's CDS spread compared to the regression in column [1]. The same observation holds for other main control variables except for some minimal changes in their estimated coefficients in terms of magnitude. In column [3], we examine the effect of the net-off trade credit leverage ratio and its counter leverage ratio, non-trade credit leverage together with the credit rating and other control variables. Net-off trade credit leverage has a positive and statistically significant estimated coefficient at the 1 percent level. However, its coefficient is almost the same

magnitude as the non-trade credit leverage ratio, which we have not observed for other leverage ratio components in the previous columns. The estimated coefficient of the credit rating is still negative and statistically significant at 1 percent but its magnitude drops to 0.193 from 0.219 in absolute terms. Regarding other control variables, there is no finding that leads us to make different interpretations compared to previous analyses.

We replicate the combined analysis of all leverage ratio components previously reported in Table IX-Column [5] in the fourth column of Table XIII by adding credit rating to the regression specification. In the regression, in which we use all leverage ratio components by account type, we find that market debt leverage is relatively the most important leverage ratio compared to others with its highest estimated coefficient of 0.044. It is also statistically significant at the 1 percent level. In terms of economic magnitude, it is followed by the net-off trade credit leverage ratio for which the estimated coefficient is 0.036 and is statistically significant at the 1 percent level. The other leverage ratio is also positive and statistically significant at the 1 percent level estimated coefficient but its coefficient (0.017) is smaller in magnitude than the other two. However, the bank debt leverage ratio no longer has a statistically significant estimated coefficient. We can explain the reason that bank debt leverage loses its statistical significance from a statistical perspective. Its *t*-statistics are small because its standard error is much larger than its mean compared to other variables, except for the net-off trade credit leverage, as we can see from the mean and the standard deviation columns of Table III. In terms of empirical interpretation, the firms in the sample are large corporations and their bank indebtedness is not as high as their indebtedness in other types of debt as seen in Table III. Therefore, we can comment that the CDS market might react to the bank debt leverage relatively less considering that they have some information about the credit quality of the firms obtained from credit rating agencies.

Finally, in the last column of Table XIII, we analyse the effects on the CDS spread of leverage ratio components with debt maturity classification by utilising credit rating as an additional regressor. Controlling for credit quality via credit rating does not change our findings from the analysis reported in Table X in Section 6. The estimated coefficients for the short-term debt leverage and long-term debt leverage ratios are positive and statistically significant at the 1 percent level. In terms of economic magnitude, long-term debt leverage still matters more than short-term debt leverage for the next quarter's CDS spread. The long-term debt leverage's coefficient is circa 1.6 times of the short-term debt leverage's coefficient. All control variables, including credit rating, have the theoretically expected signs in their estimates. They are also statistically significant at the 1 percent level.

7.4 Industry Analysis of Trade Credit Leverage:

While the main results in Section 6 show that the trade credit leverage ratio does not affect the next quarter's CDS spread statistically, it is important to understand why trade credit finance does not have implications for firms' credit risk in this sample. This analysis is crucial considering that the limited empirical studies that exist regarding trade finance, point out that trade credit is the most important source of short-term financing for firms all over the world (Rajan and Zingales, 1995; Giannetti, 2003). Auboin (2009) finds that US firms finance 90 % of the trade amongst each other via trade credit and one of the largest short-term liabilities on US firms' balance sheets is accounts payable. Moreover, on the aggregate balance sheet of nonfinancial corporate US firms, accounts payable are twice as large as bank loans and 12 times as large as commercial papers; they make up circa 10 percent of total liabilities (the US Flow of Funds Accounts, as of 2018 yearend). In spite of its economic significance, the number of academic studies conducting empirical analyses of trade credit finance is very low due to the lack of a thorough data set and an appropriate empirical setting (Jacobson and Von Schedvin, 2015; Barrot, 2016; Giannetti et al., 2019).

Published empirical studies prove that trade credit is an essential way of financing and might be a crucial source of funds for companies that have limited access to bank credit (Rajan and Zingales, 1995; Gianetti, 2003; Jacobson and Von Schedvin, 2015; Petersen and Rajan, 2017). This might be one of the reasons that we have obtained a statistically insignificant effect of trade credit leverage on the CDS spread for the firms in our sample. The firms in this sample are very large US corporations, which include well-known names for their industries. These firms are unlikely to have problems in accessing financial debt markets and banks for the sourcing of funds. Due to their size, they are usually classified as financially unconstrained firms. Despite being a liability account, their accounts payable balances may not be regarded as a possible debt factor increasing their credit risk, and, instead, serve as a signal for their credibility and market power. Their external finance stakeholders may interpret this market power signal effect in such a way that these firms have lower credit risk and can finance their operations through their suppliers. In short, it seems that the second effect, the so-called market power signal effect, cancels out the first effect, which can be referred to as the indebtedness signal effect in our regressions. Empirical evidence from the literature proposes that creditworthy firms having buyer market power use more trade credit, but they also obtain better loan deals from banks, especially lower fees for their bank credit lines (Giannetti et al., 2011).

Another noteworthy factor to mention, while evaluating the trade finance of the sample firms, is that some of these firms are very large manufacturing suppliers in their industries. In line with common industry practices, they finance their customers through their trade receivables by offering more trade credit with longer maturity to maintain their market power and to expose their finan-

cially weaker rivals to liquidity shocks (Giannetti et al., 2011, 2019; Barrot 2016). Some industry characteristics such as those of the traded products determine the trade finance relationships among the firms. For instance, Giannetti et al. (2011) find that suppliers of differentiated products and services have higher balances of account receivables than suppliers of standardised goods. In line with previous studies' findings, in Table III, the negative mean value of the net-off trade credit leverage ratio, in which we deduct accounts receivables from accounts payables and divide by the market value of total assets, provides evidence of sample firms issuing trade credit to their customers in their industries, overall. For our sample firms, a higher balance of account receivables implies a higher market power in their businesses and a sign of ongoing operations; therefore, we have found a negative effect of trade receivables/asset ratio on the next quarter's CDS spread as shown in Table XI. However, by using an extensive Swedish data set that contains information on all corporate bankruptcies associated with trade credit claims, Jacobson and Von Schedvin (2015) argue that the inter-firm linkages induced by trade credit propagate corporate failures through two effects: credit loss with failed debtors and demand effect due to a loss of future business opportunities. However, our sample firms' characteristics differ substantially from those in that study, which focuses on small- and medium-sized Swedish firms.

As we have seen from the related literature, industry-specific factors, such as market competition and different types of products and services, influence trade relationships and trade credit finance amongst firms. This leads us to another hypothesis that the trade credit leverage imposes its indebtedness signal effect on the credit risk more for the firms operating in more competitive industries. We expect that trade credit's market power signal effect does not manifest for these firms strongly enough to cancel the trade credit's indebtedness signal effect, which will lead to higher CDS spread during the firm's later periods.

To test the hypothesis above, we need to classify the industries based on their market competitiveness. Therefore, we use the Herfindahl-Hirschman Index (HHI), which is a common measure of market concentration; specifically, the HHI is a commonly used product market competition measure in empirical industrial organisation literature and is well established in theory (Tirole, 1998, pp. 221–223). It is computed as the sum of squared market shares, $HHI_{jt} = \sum_{i=1}^{N_j} s_{ijt}^2$, where s_{ijt} is the market share of firm i in industry j in year t . The original HHI values are normalised with 10,000 as common practice in the literature.

The HHI data is obtained from the US Census Bureau at the US Department of Commerce. The Census Bureau's data set includes all public and private companies in the United States. The concentration data is computed for manufacturing industries by Census Bureau every five years. Because our sample period is from 2003 to 2017, we use data from 2002, 2007, and 2012. For the

intermediate years, we always use data from the most recent available Census. The Census Bureau has provided data for various North American Industry Classification System (NAICS) partitions since 1997. We obtain the NAICS code for each firm's industry from Capital IQ and merge our main firm data set with the HHI dataset based on a six-digit NAICS code.

The US Department of Justice considers a market with an HHI value of less than 0.15 to be a competitive industry, an HHI value of 0.15 to 0.25 to be a moderately concentrated industry, and an HHI value of 0.25 or greater to be a highly concentrated industry. Based on this classification of the US Department of Justice, we define a dummy variable called HHI, which takes a value of 1 if the HHI value is less 0.15, implying that an industry is competitive, and a value of 0 if the HHI value is equal to and greater than 0.15, showing that the industry is concentrated.

As a next step, we develop our main regression specification in which we use all leverage ratio components by interacting the dummy variable with each of these component ratios: market debt leverage, bank debt leverage, trade credit leverage, and other leverage. We also interact this dummy with the main control variables. We continue using firm- and time-fixed effects in the regression specifications but drop industry-by-quarter fixed effects, because the dummy variable for industry concentration has already controlled for specific industry characteristics.

In these regressions, our main independent variable is the trade credit leverage ratio. Table XIV provides the results of the regressions. In the first column, we present the results of the regression without using the dummy variable to make an initial comparison. The second column shows the results of the new regression specification. As shown earlier in this paper, the coefficient of trade credit leverage is negative and statistically insignificant in the first column. However, its interaction term with the HHI dummy variable is positive and statistically significant at the 10 percent level. This result implies that a higher trade credit leverage leads to a higher CDS spread next quarter for firms operating in the competitive industries. The indebtedness signal effect of trade credit leverage is more influential for these firms in competitive industries. Therefore, any indebtedness of a firm from its accounts payable, does matter for the CDS market if the firm is in a competitive industry. However, when a firm operates in an industry in which product market competition is low, and probably has some kind of market power, a higher trade credit indebtedness is not translated into a higher credit risk. We can argue that the market power signal effect of trade credit cancels out its indebtedness signal effect for the firms in concentrated markets.

8 Conclusion

This paper is the first step towards better understanding how different components of the leverage ratio that correspond with different types of debt influence CDS spreads. Firms have different kinds of debt in their liabilities depending whom they are indebted to and at which time horizon they need to pay back their debt. The pecking order theory (Myers and Majluf, 1984) suggests that investors who have less knowledge of the firm and the industry should face more severe asymmetric information problems. Therefore, we hypothesise that the CDS market attributes a different level of credit risk to each debt component: (i) debt to financial markets as high risk; (ii) debt to banks as medium risk; and (iii) debt to trade partners as low risk.

In our empirical analysis, we use CDS and stock data as well as financial statement data obtained from Capital IQ. We discretise the leverage ratio into different components according to both account type and debt maturity. Our main finding is that the market debt leverage and the bank debt leverage have a statistically and economically significant positive effect on next quarter's CDS spread, whereas the trade credit leverage ratio is not significant in explaining the CDS spread for all of the sample's firms. Second, we document that the market debt leverage ratio has the highest estimated positive coefficient when we regress the CDS spread on all leverage ratio components. These results are consistent with the hypotheses derived from the pecking order theory (Myers and Majluf, 1984): the CDS market attributes higher credit risk to the debt type with higher information asymmetry.

We document that there is a negative relationship between accounts receivable/total asset ratio and CDS spread. Since accounts receivable is a part of the firm's asset value, this result is in line with the Merton Model (Merton, 1974), proposing that the higher the asset value, the lower the credit risk. Accounts receivable represent future cash flows from the customers that the firm will gain. The CDS market may evaluate that a firm with a higher balance of accounts receivable is likely to continue its business in the future without any stagnation in its cash flows.

We show that the trade credit leverage ratio raises the CDS spread of the firms in the competitive industries. Increased indebtedness due to accounts payable matters for a firm's credit risk in an industry where market competition is high. On the other hand, debt to the suppliers does not raise a firm's credit risk if the firm operates in less competitive industries. At least, the CDS investors do not attribute much credit risk to accounts payable of these firms that have the market power. The CDS market may interpret accounts payable as a signal for the borrower firm's credibility in its product market.

Policy Implications: Our findings, thus, suggest that firm credit risk depends on the type of

debt. The situation of a firm being indebted to better-informed lenders (trade suppliers and banks) reduces its credit risk perceived by the market compared to the situation in which a firm is more indebted to less-informed lenders who are investors in financial markets. This result suggests that financial market regulators should not only pay attention to debt level and, therefore, debt ratios, but should also evaluate the different types of debt in each firm's capital structure. In particular, high levels of market debt seems to be associated with the high credit risk perceived by the credit market in an economy.

Weaknesses: The main weakness of our study is that the firms in the data set are very large and stable and their credit (default) risk should be low in comparison to an average-sized firm in the US and in other developed countries. These results might not be valid for small-sized firms. The latter type of firms and their debt composition might matter differently to their credit risk. We might also underestimate the effects of other debt categories (bank debt, trade credit) on credit risk. We acknowledge that, first, smaller firms do not have much access to market debt, and second, financial markets in many countries are not as developed as they are in the US.

Another weakness of this study is the endogeneity concern that implies that firms with higher credit risk might not borrow from the financial markets. Therefore, their creditworthiness influences their debt composition. At this point, we consider that the size of the firms, and being publicly quoted, are the most important features that determine access to the financial markets. In our sample, large-capitalisation firms with relatively higher creditworthiness have the opportunity to choose their debt composition.

Future Research: Our results show that borrowing from a trade partner is associated with low risk. However, this does not directly imply that borrowing from a trade partner is more profitable since the trade partner might have strong bargaining power against the borrower firm. Therefore, the trade partner may want to squeeze a lot out of the deal, but this might be so much that the borrower could go into bankruptcy or be forced to exit the industry, i.e. the lender should not bite the hand that feeds it. Testing this possible relationship will be a productive research direction.

Regression Tables

Table V
Regressions of CDS Spread on Market Debt Leverage

The regressions in this table examine the impact of market debt on CDS spread. The dependent variable in these regressions is CDS spread that is the quarterly mean of daily CDS spreads. In all specifications, the dependent variable CDS spread has a lead of one period (quarter) with respect to all independent variables. The main independent variable, market debt leverage, is calculated by a ratio of market debt over market value of assets. Market debt consists of commercial papers, bonds, capital & finance lease obligations, federal loans, and other short-term & long-term borrowing derivatives. It is simply the sum of financial debts other than bank debts. The second independent variable, called “non-fin debt leverage”, is calculated by total liabilities minus market debt over market value of assets. Return is quarterly mean value of daily logarithmic returns. Market capitalization (cap) is quarterly average of daily market capitalization that is $price \times total\ number\ of\ outstanding\ shares$. Equity volatility is stock return volatility that is quarterly standard deviation of daily stock returns. Income/asset is the ratio of net income to total asset. All variables are trimmed at the upper and lower 0.05-percentiles. In all regressions, *t-statistics* are calculated using robust standard errors that are clustered at firm and quarter levels. They are reported in parentheses.

	(1)	(2)	(3)	(4)	(5)
Market Debt Lev	0.105*** (12.19)	0.0620*** (8.51)	0.0618*** (8.02)	0.0509*** (6.42)	0.0503*** (6.43)
Non-mrkt Debt Lev	0.0611*** (7.37)	0.0326*** (5.13)	0.0314*** (4.32)	0.0233*** (3.40)	0.0212*** (3.01)
Return		-0.00125* (-1.93)	-0.00154*** (-4.10)	-0.00167*** (-4.36)	-0.00175*** (-3.58)
Market cap		-0.196*** (-3.65)	-0.503*** (-3.84)	-0.681*** (-5.58)	-0.651*** (-5.10)
Equity volatility		0.0462*** (8.13)	0.0315*** (6.63)	0.0385*** (9.92)	0.0389*** (9.75)
Income/Asset		-0.0393*** (-3.02)	-0.0464*** (-5.91)	-0.0479*** (-6.33)	-0.0451*** (-5.34)
Adj. R-squared	0.412	0.553	0.760	0.782	0.796
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	337	337	335	335	333
N. of Obs.	14517	14235	14233	14233	13943

Note: ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Table VI
Regressions of CDS Spread on Bank Debt Leverage

The regressions in this table examine the impact of bank debt leverage on the CDS spread. The dependent variable in these regressions is CDS spread that is the quarterly mean of daily CDS spreads. In all specifications, the dependent variable CDS spread has a lead of one period (quarter) with respect to all independent variables. The main independent variable, bank debt leverage, is calculated by a ratio of total bank debt over market value of assets. The second independent variable, called “non-bank debt leverage”, is calculated by total liabilities minus bank debt over market value of assets. Return is quarterly mean value of daily logarithmic returns. Market capitalization (cap) is quarterly average of daily market capitalization that is $price \times total\ number\ of\ outstanding\ shares$. Equity volatility is stock return volatility that is quarterly standard deviation of daily stock returns. Income/asset is the ratio of net income to total asset. All variables are trimmed at the upper and lower 0.05-percentiles. In all regressions, *t-statistics* are calculated using robust standard errors that are clustered at firm and quarter levels. They are reported in parentheses.

	(1)	(2)	(3)	(4)	(5)
Bank Debt Lev	0.155*** (9.72)	0.103*** (7.44)	0.0738*** (5.33)	0.0607*** (4.76)	0.0661*** (5.43)
Non-bank Debt Lev	0.0746*** (10.57)	0.0393*** (7.39)	0.0485*** (8.26)	0.0389*** (6.84)	0.0383*** (6.56)
Return		-0.00136** (-2.18)	-0.00141*** (-3.89)	-0.00153*** (-4.01)	-0.00158*** (-3.27)
Market cap		-0.232*** (-4.47)	-0.443*** (-3.40)	-0.633*** (-5.16)	-0.573*** (-4.51)
Equity volatility		0.0451*** (7.96)	0.0310*** (6.45)	0.0382*** (9.98)	0.0386*** (9.74)
Income/Asset		-0.0435*** (-3.17)	-0.0482*** (-5.89)	-0.0495*** (-6.43)	-0.0441*** (-5.33)
Adj. R-squared	0.414	0.558	0.760	0.782	0.796
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	337	337	335	335	333
N. of Obs.	14517	14235	14233	14233	13943

Note: ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Table VII
Regressions of CDS Spread on Trade Credit Leverage

The regressions in this table examine the effect of trade credit leverage on the CDS spread that proxies credit risk. The dependent variable in these regressions is CDS spread that is the quarterly mean of daily CDS spreads. In all specifications, the dependent variable CDS spread has a lead of one period (quarter) with respect to all independent variables. The main explanatory variable, trade credit leverage, is calculated by the ratio of trade payable over market value of assets. The second independent variable, called “non-trade credit leverage”, is calculated by total liabilities minus trade payable over market value of assets. Return is quarterly mean value of daily logarithmic returns. Market capitalization (cap) is quarterly average of daily market capitalization that is *price × total number of outstanding shares*. Equity volatility is stock return volatility that is quarterly standard deviation of daily stock returns. Income/asset is the ratio of net income to total asset. All variables are trimmed at the upper and lower 0.05-percentiles. In all regressions, *t-statistics* are calculated using robust standard errors that are clustered at firm and quarter levels. They are reported in parentheses.

	(1)	(2)	(3)	(4)	(5)
Trade Credit Lev	0.0426*** (4.25)	0.0105 (1.21)	0.0212 (1.33)	0.00750 (0.48)	0.0100 (0.59)
Non-trade Credit Lev	0.0870*** (11.83)	0.0484*** (8.74)	0.0541*** (9.37)	0.0445*** (7.98)	0.0442*** (7.59)
Return		-0.00138** (-2.15)	-0.00144*** (-3.80)	-0.00154*** (-4.03)	-0.00160*** (-3.23)
Market cap		-0.258*** (-4.97)	-0.423*** (-3.21)	-0.617*** (-4.99)	-0.566*** (-4.36)
Equity volatility		0.0449*** (7.92)	0.0310*** (6.45)	0.0380*** (10.06)	0.0386*** (9.72)
Income/Asset		-0.0410*** (-3.08)	-0.0476*** (-6.02)	-0.0487*** (-6.44)	-0.0447*** (-5.26)
Adj. R-squared	0.408	0.555	0.761	0.783	0.796
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	337	337	335	335	333
N. of Obs.	14427	14145	14143	14143	13853

Note: ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Table VIII
Regressions of CDS Spread on Net-off Trade Credit Leverage

The regressions in this table examine the effect of net-off trade credit leverage on the CDS spread. The dependent variable in these regressions is CDS spread that is the quarterly mean of daily CDS spreads. In all specifications, the dependent variable CDS spread has a lead of one period (quarter) with respect to all independent variables. The main explanatory variable, net-off trade credit leverage, is calculated by the ratio of trade payables minus trade receivables over market value of assets. The second independent variable, called “non-trade credit leverage”, is calculated by total liabilities minus trade payables over market value of assets. Return is quarterly mean value of daily logarithmic returns. Market capitalization (cap) is quarterly average of daily market capitalization that is $price \times total\ number\ of\ outstanding\ shares$. Equity volatility is stock return volatility that is quarterly standard deviation of daily stock returns. All variables are trimmed at the upper and lower 0.05-percentiles. In all regressions, *t*-statistics are calculated using robust standard errors that are clustered at firm and quarter levels. They are reported in parentheses.

	(1)	(2)	(3)	(4)	(5)
Net-off trade credit lev	0.0371** (2.45)	0.0376*** (3.23)	0.0597*** (3.73)	0.0524*** (3.46)	0.0594*** (4.37)
Non-trade credit lev	0.0876*** (11.63)	0.0486*** (8.78)	0.0564*** (9.47)	0.0480*** (8.27)	0.0483*** (8.37)
Return		-0.00141** (-2.24)	-0.00145*** (-3.89)	-0.00143*** (-3.78)	-0.00146*** (-3.00)
Market cap		-0.278*** (-5.58)	-0.417*** (-3.51)	-0.575*** (-5.04)	-0.528*** (-4.57)
Equity volatility		0.0445*** (7.98)	0.0310*** (6.52)	0.0369*** (9.52)	0.0372*** (9.15)
Income/Asset		-0.0399*** (-2.96)	-0.0444*** (-5.63)	-0.0458*** (-5.96)	-0.0413*** (-4.74)
Adj. R-squared	0.403	0.559	0.764	0.785	0.801
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	336	336	334	334	332
N. of Obs.	14097	13822	13820	13820	13488

Note: ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Table IX**Regressions of CDS Spread on Market Debt, Bank Debt, and Net-off Trade Credit Leverage Ratios**

The regressions examine the impacts of market debt, bank debt and net-off trade credit leverage ratios on the CDS spread. The dependent variable in these regressions is CDS spread with a lead of one quarter ahead of other variables. The independent variables of interest are market debt, bank debt and net-off trade credit leverages. The independent variable, called “other leverage”, depicts the leverage stemming from the remaining debt in the total liabilities of each firm. It is calculated by total liabilities minus accounts payable, bank debt and market debt over market value of assets. The remaining control variables are calculated in the same manner as in the previous regression tables. All variables are trimmed at the upper and lower 0.05-percentiles. In all regressions, *t*-statistics are calculated using robust standard errors that are clustered at firm and quarter levels. They are reported in parentheses.

	(1)	(2)	(3)	(4)	(5)
Market Debt Lev	0.0943*** (9.20)	0.0507*** (6.15)	0.0590*** (6.68)	0.0496*** (5.47)	0.0493*** (5.62)
Bank Debt Lev	0.125*** (5.10)	0.0863*** (4.55)	0.0437** (2.13)	0.0346* (1.90)	0.0384** (2.36)
Net-off Trade Credit Lev	0.0398*** (2.71)	0.0388*** (3.36)	0.0493*** (2.92)	0.0427*** (2.68)	0.0469*** (3.21)
Other Leverage	0.0676*** (6.60)	0.0372*** (5.02)	0.0323*** (3.39)	0.0254*** (2.98)	0.0242*** (2.94)
Return		-0.00140** (-2.31)	-0.00165*** (-4.53)	-0.00169*** (-4.31)	-0.00172*** (-3.48)
Market cap		-0.244*** (-4.84)	-0.555*** (-4.10)	-0.703*** (-5.49)	-0.678*** (-5.25)
Equity volatility		0.0451*** (8.19)	0.0317*** (6.57)	0.0377*** (9.45)	0.0379*** (9.18)
Income/Asset		-0.0405*** (-2.99)	-0.0447*** (-5.61)	-0.0466*** (-6.04)	-0.0429*** (-5.06)
Adj. R-squared	0.415	0.567	0.763	0.784	0.800
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	336	336	334	332	333
N. of Obs.	14097	13822	13820	13820	13488

Note: ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Table X
Regressions of CDS Spread on Short-term and Long-term Liabilities

This table presents the effect of liabilities classified according to their maturity on the CDS spread. The dependent variable in these regressions is CDS spread that is the quarterly mean of daily CDS spreads. It has a lead of one period (quarter) with respect to all independent variables. The independent variables of interest are short-term (ST) liabilities and long term (LT) liabilities. ST liabilities are the debts that are due within a year, whereas LT liabilities are the debt whose maturities are longer than 1 year as of balance sheet date. The remaining control variables are calculated in the same manner as in the previous regression tables. All variables are trimmed at the upper and lower 0.05-percentiles. In all regressions, *t-statistics* are calculated using robust standard errors that are clustered at firm and quarter levels. They are reported in parentheses.

	(1)	(2)	(3)	(4)	(5)
Short-term Debt Lev	0.0624*** (6.08)	0.0291*** (3.64)	0.0260*** (2.85)	0.0189** (2.19)	0.0216** (2.41)
Long-term Debt Lev	0.0879*** (11.35)	0.0479*** (8.17)	0.0530*** (8.39)	0.0425*** (6.77)	0.0419*** (6.68)
Return		-0.00145** (-2.23)	-0.00161*** (-4.28)	-0.00171*** (-4.33)	-0.00172*** (-3.42)
Market cap		-0.254*** (-4.73)	-0.502*** (-3.68)	-0.688*** (-5.43)	-0.627*** (-4.82)
Equity volatility		0.0460*** (8.05)	0.0317*** (6.63)	0.0387*** (9.82)	0.0391*** (9.66)
Income/Asset		-0.0441*** (-3.25)	-0.0494*** (-6.21)	-0.0507*** (-6.72)	-0.0466*** (-5.53)
Adj. R-squared	0.391	0.545	0.758	0.780	0.794
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	337	337	335	335	333
N. of Obs.	14517	14235	14233	14233	13943

Note: ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Table XI
Regressions of CDS Spread on Trade Receivable/Asset Ratio

This table examines the effect of trade (accounts) receivable on the CDS spread. The dependent variable in these regressions is CDS spread that is the quarterly mean of daily CDS spreads. In all specifications, the dependent variable CDS spread has a lead of one period (quarter) with respect to all independent variables. The main independent variable, trade receivable/total asset, is calculated by a ratio of trade receivable to market value of assets. The second independent variable, called “total leverage”, is calculated by total liabilities over market value of assets. The other control variables are calculated in the same manner as in the previous tables. All variables are trimmed at the upper and lower 0.05-percentiles. In all regressions, *t*-statistics are calculated using robust standard errors that are clustered at firm and quarter levels. They are reported in parentheses.

	(1)	(2)	(3)	(4)	(5)
Trade receivable/asset	-0.0450*** (-3.29)	-0.0560*** (-4.85)	-0.0730*** (-3.53)	-0.0756*** (-3.85)	-0.0755*** (-3.98)
Total leverage	0.0853*** (11.46)	0.0462*** (8.67)	0.0527*** (8.77)	0.0434*** (7.44)	0.0438*** (7.57)
Return		-0.00152** (-2.47)	-0.00164*** (-4.30)	-0.00171*** (-4.24)	-0.00173*** (-3.47)
Market cap		-0.304*** (-5.68)	-0.501*** (-3.37)	-0.687*** (-4.93)	-0.639*** (-4.49)
Equity volatility		0.0450*** (8.02)	0.0312*** (6.50)	0.0370*** (9.42)	0.0373*** (9.08)
Income/asset		-0.0426*** (-3.20)	-0.0455*** (-5.70)	-0.0474*** (-6.09)	-0.0434*** (-4.96)
Adj. R-squared	0.398	0.556	0.763	0.785	0.801
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	336	336	334	334	332
N. of Obs.	14186	13911	13909	13909	13577

Note: ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Table XII

Regressions of Credit Risk on Equity Book Value-based Leverage Ratio Components

The regressions examine the impacts of total leverage ratio and its components on the CDS spread while controlling for the firm credit rating. The dependent variable in all these regressions is CDS spread with a lead of one quarter ahead of other variables. The independent variables of interest are leverage ratio components. They are computed using the book value of equity rather than the market value of equity. All variables are trimmed at the upper and lower 0.05-percentiles. In all regressions, *t-statistics* are calculated using robust standard errors that are clustered at firm and quarter levels. They are reported in parentheses.

	(1)	(2)	(3)	(4)	(5)
Total Leverage	0.0148*** (3.51)				
Market debt lev		0.0194*** (3.95)			0.0192*** (3.39)
Non-market debt lev		0.00745 (1.19)			
Bank debt lev			0.0351*** (3.99)		0.0226** (2.14)
Non-bank lev			0.0356*** (5.98)		
Net-off trade credit lev				0.0177** (2.07)	0.0171* (1.93)
Non-trade credit lev				0.0155*** (3.62)	
Other leverage					0.0168*** (3.20)
Return	-0.00270*** (-5.48)	-0.00270*** (-5.50)	-0.00175*** (-3.46)	-0.00259*** (-5.07)	-0.00262*** (-5.13)
Market cap	-0.989*** (-8.19)	-1.002*** (-8.25)	-0.638*** (-4.81)	-0.967*** (-8.26)	-0.963*** (-8.27)
Equity volatility	0.0404*** (9.58)	0.0404*** (9.60)	0.0392*** (9.74)	0.0396*** (9.07)	0.0393*** (9.06)
Income/asset	-0.0570*** (-6.57)	-0.0559*** (-6.58)	-0.0466*** (-5.47)	-0.0553*** (-6.35)	-0.0534*** (-6.13)
Adj. R-squared	0.789	0.790	0.794	0.793	0.794
Firm & Time FEs	Yes	Yes	Yes	Yes	Yes
Industry x Time FE	Yes	Yes	Yes	Yes	Yes
N. of Firms	333	333	333	332	332
N. of Obs.	13943	13943	13943	13488	13488

***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Table XIII**Regressions of CDS Spread on Leverage Ratio Components with Credit Ratings**

The regressions examine the impacts of leverage ratio components on the CDS spread while controlling for the firm credit rating. The dependent variable in all these regressions is CDS spread with a lead of one quarter ahead of other variables. The independent variables of interest are leverage ratio components. The control variables are calculated in the same manner as in the previous regression tables. All variables are trimmed at the upper and lower 0.05-percentiles. In all regressions, *t-statistics* are calculated using robust standard errors that are clustered at firm and quarter levels. They are reported in parentheses.

	(1)	(2)	(3)	(4)	(5)
Market debt lev	0.0433*** (5.14)			0.0444*** (4.78)	
Non-market debt lev	0.0184** (2.58)				
Bank debt lev		0.0510*** (4.28)		0.0222 (1.42)	
Non-bank lev		0.0342*** (5.52)			
Net-off trade credit lev			0.0484*** (3.51)	0.0359** (2.39)	
Non-trade credit lev			0.0422*** (6.91)		
Other leverage				0.0170** (2.10)	
Short-term debt lev					0.0214** (2.19)
Long-term debt lev					0.0353*** (5.29)
Return	-0.00231*** (-4.46)	-0.00215*** (-4.14)	-0.00201*** (-3.93)	-0.00226*** (-4.29)	-0.00229*** (-4.26)
Market cap	-0.430*** (-3.69)	-0.352*** (-2.98)	-0.348*** (-3.19)	-0.488*** (-4.20)	-0.403*** (-3.41)
Equity volatility	0.0364*** (8.97)	0.0362*** (8.99)	0.0355*** (8.49)	0.0359*** (8.52)	0.0366*** (8.95)
Income/asset	-0.0462*** (-5.46)	-0.0454*** (-5.35)	-0.0434*** (-5.02)	-0.0450*** (-5.20)	-0.0474*** (-5.64)
Credit rating	-0.218*** (-5.29)	-0.219*** (-5.35)	-0.193*** (-4.67)	-0.199*** (-4.62)	-0.223*** (-5.23)
Adj. R-squared	0.805	0.805	0.810	0.808	0.804
Fixed Effects	Yes	Yes	Yes	Yes	Yes
N. of Firms	307	307	306	306	307
N. of Obs.	13153	13153	12708	12708	13153

Note: ***, ** and * denote significance at the 1%, 5% and 10% levels respectively. Fixed effects are firm, time and industry x time fixed effects

Table XIV

Regressions of Credit Risk on Trade Credit Leverage with Industry Concentration

This table reports the results from panel regressions of CDS spread on trade credit leverage, HHI dummy, other leverage ratio components, control variables and interaction terms between the HHI dummy and leverage ratio components as well as control variables. The HHI dummy indicates whether HHI value of a specific industry is less than 0.15 and the industry is classified as a competitive market. All other regression variables are calculated in the same manner as in the previous regression tables. All regressions include firm and time (quarter) fixed effects. All variables are trimmed at the upper and lower 0.05-percentiles. In all specifications, *t-statistics* are calculated using robust standard errors that are clustered at firm and quarter levels. They are reported in parentheses.

	(1)	(2)
Trade Credit Lev	-0.000404 (-0.02)	-0.0205 (-1.07)
Trade Credit Lev x HHI		0.0526** (2.40)
HHI		-2.398* (-1.70)
Market Debt Lev	0.0467*** (5.30)	0.0400*** (3.90)
Bank Debt Lev	0.0357** (2.02)	0.0518** (2.46)
Other Leverage	0.0203** (2.45)	0.0291*** (3.09)
Return	-0.00184*** (-4.52)	-0.00190*** (-4.88)
Market cap	-0.753*** (-5.41)	-0.800*** (-5.62)
Equity volatility	0.0386*** (9.96)	0.0407*** (9.08)
Income/Asset	-0.0490*** (-6.36)	-0.0455*** (-5.59)
Adj. R-squared	0.782	0.785
Independent Variables x HHI	No	Yes
Firm & Times FEs	Yes	Yes
N. of Firms	335	335
N. of Obs.	14143	14143

***, ** and * denote significance at the 1%, 5% and 10% levels respectively. The specification in column 2 also includes the interaction terms between the HHI dummy and other leverage ratio components as well as control variables. Their results are not reported due to lack of space.

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Appendix

Table XV
Creditor Ratings Numerical Scale

This table presents the conversion S&P credit rating notation to a numerical scale according to the study of Almeida et al. (2017).

Numerical Rating: S&P Rating	
22	AAA
21	AA+
20	AA
19	AA-
18	A+
17	A
16	A-
15	BBB+
14	BBB
13	BBB-
12	BB+
11	BB
10	BB-
9	B+
8	B
7	B-
6	CCC+
5	CCC
4	CCC-
3	CC
2	C
1	SD/D

Table XVI**Regressions of CDS Spread on Market Debt, Bank Debt, and Trade Credit Leverage Ratios**

The regressions examine the impacts of market debt leverage, bank debt leverage and trade credit leverage on the CDS spread. The dependent variable in these regressions is CDS spread with a lead of one quarter ahead of other variables. The independent variables of interest (market debt, bank debt, and trade credit leverage ratios) are calculated by a ratio of each of these debt to market value of assets respectively. The independent variable, called “other leverage”, depicts the remaining debt in the total liabilities of each firm. It is calculated by total liabilities minus account payable, bank debt and market debt over market value of assets. The remaining control variables are calculated in the same manner as in the previous regression tables. All variables are trimmed at the upper and lower 0.05-percentiles. In all regressions, *t-statistics* are calculated using robust standard errors that are clustered at firm and quarter levels. They are reported in parentheses.

	(1)	(2)	(3)	(4)	(5)
Market Debt Lev	0.0940*** (9.42)	0.0511*** (6.22)	0.0571*** (6.50)	0.0467*** (5.30)	0.0458*** (5.38)
Bank Debt Lev	0.123*** (5.23)	0.0868*** (4.67)	0.0460** (2.31)	0.0357** (2.02)	0.0375** (2.35)
Trade Credit Lev	0.0448*** (4.49)	0.0135 (1.56)	0.0133 (0.81)	-0.000404 (-0.02)	-0.00110 (-0.06)
Other Leverage	0.0658*** (6.64)	0.0365*** (4.99)	0.0278*** (3.06)	0.0203** (2.45)	0.0178** (2.09)
Return		-0.00136** (-2.20)	-0.00169*** (-4.47)	-0.00184*** (-4.52)	-0.00192*** (-3.75)
Market cap		-0.219*** (-4.15)	-0.579*** (-3.86)	-0.753*** (-5.41)	-0.733*** (-4.94)
Equity volatility		0.0455*** (8.14)	0.0316*** (6.50)	0.0386*** (9.96)	0.0390*** (9.72)
Income/Asset		-0.0411*** (-3.07)	-0.0472*** (-5.85)	-0.0490*** (-6.36)	-0.0461*** (-5.53)
Adj. R-squared	0.420	0.562	0.760	0.782	0.796
Firm FE	-	-	Yes	Yes	Yes
Time FE	-	-	-	Yes	Yes
Industry x Time FE	-	-	-	-	Yes
N. of Firms	337	337	335	335	333
N. of Obs.	14427	14145	14143	14143	13853

Note: ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Figures: Bivariate Plots of Control Variables with CDS Spread

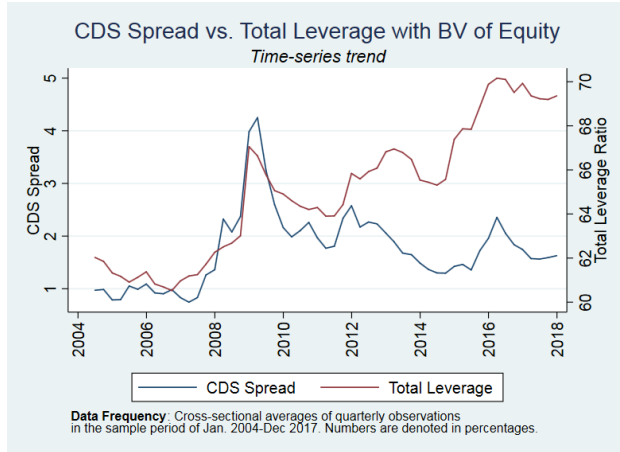


Figure 5: A Time Series Analysis of CDS Spread and Book Value-based Total Leverage

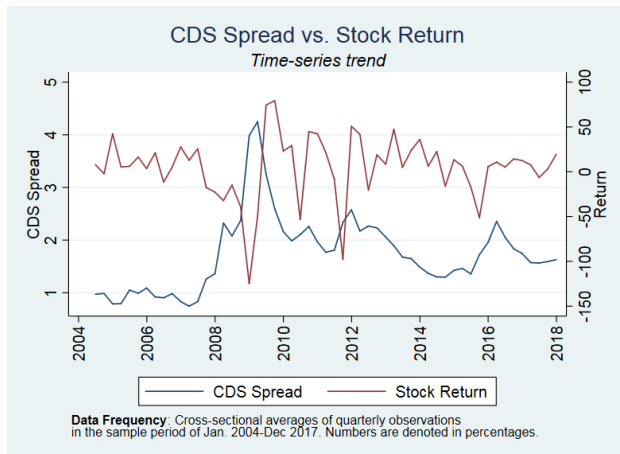


Figure 6: A Time Series Analysis of CDS Spread and Stock Return

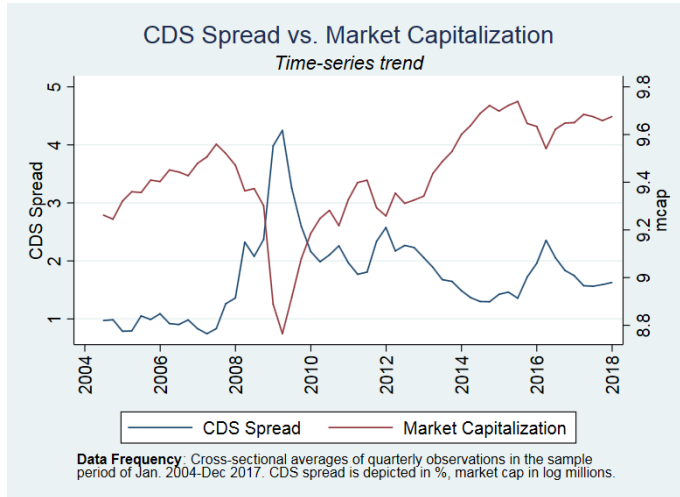


Figure 7: A Time Series Analysis of CDS Spread and Stock Market Capitalisation

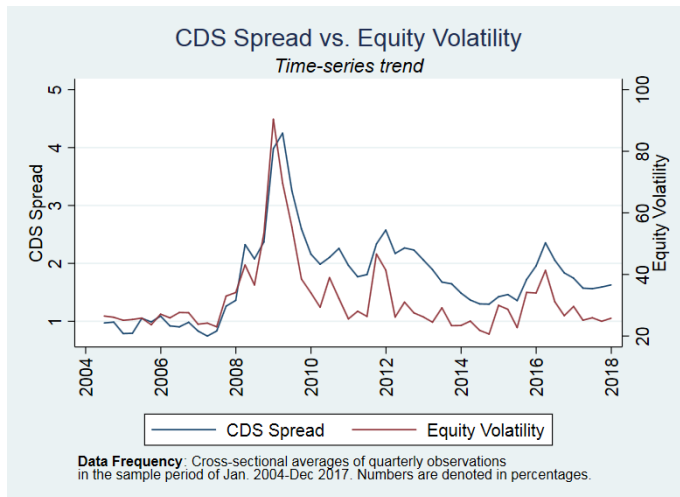


Figure 8: A Time Series Analysis of CDS Spread and Equity Volatility

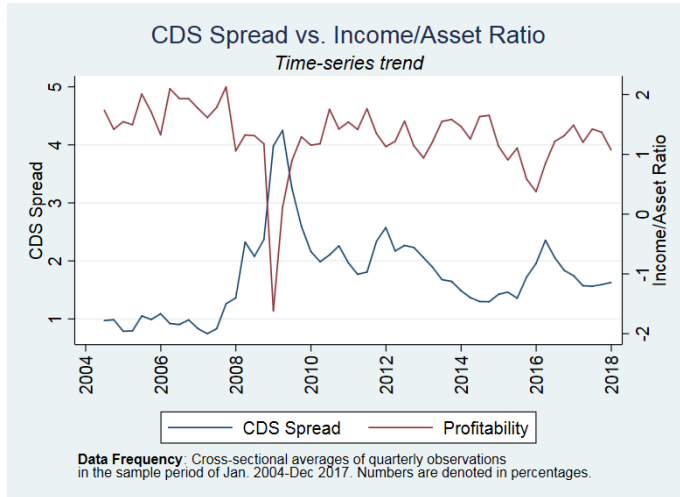


Figure 9: A Time Series Analysis of CDS Spread and Profitability

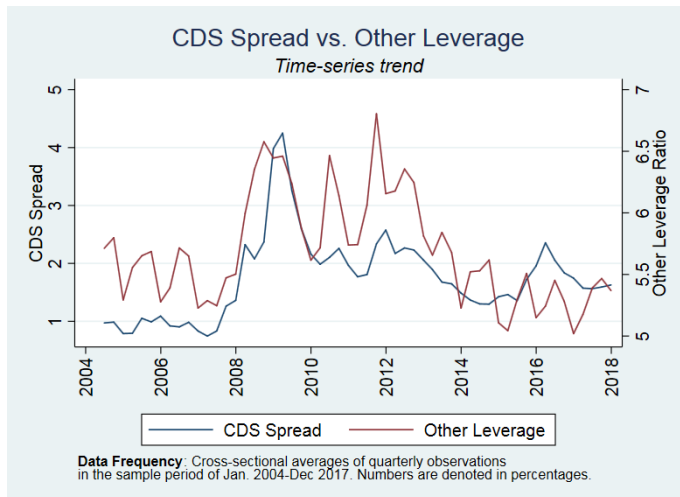


Figure 10: A Time Series Analysis of CDS Spread and Other (Remaining) Leverage

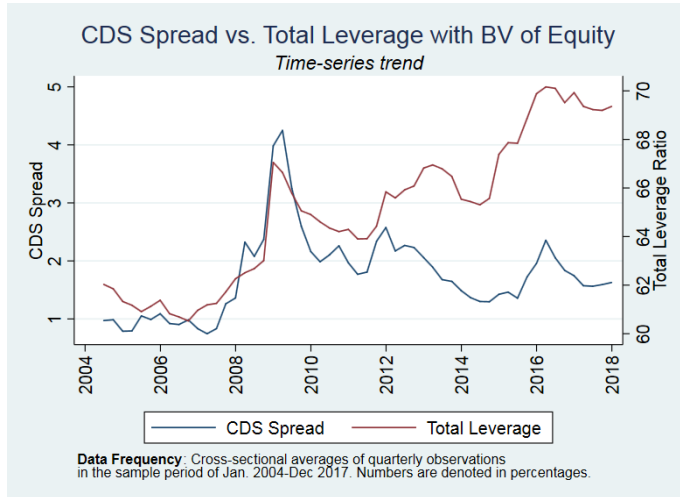


Figure 11: A Time Series Analysis of CDS Spread and BV-based Total Leverage

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