

Trade Credit Use during a Financial Crisis: Evidence from the U.K. of a Non-Existing Trade Credit Channel

Finance

Master's thesis

Riikka Alatalo

2010

Aalto University
School of Economics
Master's Thesis
Riikka Alatalo

Abstract
September 20, 2010

TRADE CREDIT USE DURING A FINANCIAL CRISIS:
EVIDENCE FROM THE U.K. OF A NON-EXISTING TRADE CREDIT CHANNEL

PURPOSE OF THE STUDY

Extensive previous research exists on the use of trade credit during tight monetary policy. Several studies have found evidence of a trade credit channel when monetary policy triggers bank credit rationing, but prior research on trade credit during financial crises is still limited. The results of Love et al. (2007) from large firms in developing markets suggest the use of trade credit may behave differently in a severe credit crunch than during times of tight monetary policy. This study broadens the previous research on trade credit use by concentrating on both large and small firms in a developed financial market during a crisis, and asks whether the use of trade credit changes during a financial crisis, and whether firms' vulnerability to the crisis affects this potential change.

DATA

The analysis is based on a panel data of 1,084 manufacturing firms in the U.K. collected from Orbis database. The firms are versatile in terms of size and public listing. The research period ranges from 2004 to 2008, in which the last two years are treated as crisis years and the previous years are included for comparison.

RESULTS

The results show robust evidence of a declining use of trade credit in 2008 and some limited evidence of a decline already in 2007. There is no support for a trade credit channel. Firm size is found to be positively related with the provision of trade credit in 2008, but the magnitude of the effect is small in relation to the overall negative effect of the year. Larger firms seem to be decreasing their provision of trade credit less than smaller firms, but size is also positively related to change in obtained trade credit during both 2007 and 2008.

KEYWORDS

Trade credit, financial crisis, financing channels

Aalto-yliopiston kauppakorkeakoulu

Tiivistelmä

Pro Gradu -tutkielma

20. syyskuuta 2010

Riikka Alatalo

TRADE CREDIT USE DURING A FINANCIAL CRISIS:
EVIDENCE FROM THE U.K. OF A NON-EXISTING TRADE CREDIT CHANNEL

TUTKIELMAN TAVOITTEET

Aiempi kauppaluottoja kireän rahapolitiikan aikana käsittelevä tutkimus on laajaa. Useat tutkimukset ovat löytäneet näyttöä kauppaluottojen rahoituskanavasta aikoina, jolloin pankkiluottojen saanti on rahapolitiikan seurauksena rajoittunutta, mutta aiempi tutkimus kauppaluotoista rahoitusmarkkinoiden kriisiaikoina on vielä vähäistä. Love et al. (2007) tutkivat suuria yrityksiä kehittyvillä markkinoilla, ja heidän tuloksensa viittaavat siihen, että kauppaluottojen rooli on erilainen vakavan luottopulan olosuhteissa kuin kireän rahapolitiikan aikoina. Tämä Pro Gradu -työ laajentaa aiempaa tutkimusta kauppaluottojen käyttöön sekä suurissa että pienissä yrityksissä rahoitusmarkkinoiden kriisin aikana kehittyneillä markkinoilla ja kysyy, muuttuuko kauppaluottojen käyttö rahoitusmarkkinoiden kriisin aikana ja, vaikuttaako yritysten suojaamattomuus kriisille tähän potentiaaliseen muutokseen.

LÄHDEAINEISTO

Lähdeaineistona käytetään 1 084 isobritannialaisen valmistustuotantoa harjoittavan yrityksen otosta, joka on kerätty Orbis-tietokannasta. Yritykset ovat vaihtelevia koon ja pörssilistautumisen osalta. Tutkimusperiodi kattaa vuodet 2004-2008, joista vuosia 2007 ja 2008 käsitellään kriisivuosina ja aiemmat vuodet ovat mukana vertailukohtana.

TULOKSET

Tutkimuksessa löytyy vahvaa näyttöä kauppaluottojen käytön vähenemisestä vuonna 2008 sekä suppeampia merkkejä vähenemisestä jo vuonna 2007. Tutkimustuloksissa ei näy merkkejä kauppaluottojen rahoituskanavasta. Yrityksen koko on positiivisesti yhteydessä kauppaluottojen myöntämiseen vuonna 2008, mutta vaikutuksen suuruusluokka on pieni verrattuna ko. vuoden yleiseen negatiiviseen vaikutukseen. Tulokset viittaavat siihen, että suuremmat yritykset vähentävät kauppaluottojen myöntämistä lievemmin kuin pienemmät yritykset, mutta yrityksen koko on myös positiivisesti yhteydessä saatuihin kauppaluottoihin sekä vuonna 2007 että 2008.

AVAINSANAT

Kauppaluotot, rahoitusmarkkinakriisi, rahoituskanavat

Contents

- 1. Introduction 1
- 2. Theoretical Background 7
 - 2.1. Transaction Motives 7
 - 2.1.1. Asymmetric Information between the Supplier and the Customer 8
 - 2.1.2. Price Discrimination 8
 - 2.1.3. Supplier's Implicit Equity Stake in the Customer Firm 8
 - 2.2. Financing Motives 9
 - 2.2.1. Suppliers' Financing Advantage over Banks 10
 - 2.2.2. Substitution of Trade Credit and Other Sources of Financing 11
 - 2.3. Trade Credit Channel 13
- 3. A Brief Overview of Trade Credit Use in the U.K. 18
- 4. Hypotheses 21
- 5. Methodology 24
 - 5.1. Fixed Effects Panel Regression 24
 - 5.2. Cluster Robust Error Terms 26
 - 5.3. Statistical Models and Variables 27
 - 5.3.1. Trade Credit Measures 27
 - 5.3.2. Aggregate Patterns 28
 - 5.3.3. Cross-Sectional Patterns 30
- 6. Data 32
 - 6.1. Descriptive Statistics 33
- 7. Results 39
 - 7.1. ANOVA Analysis of Difference in the Aggregate Means 39
 - 7.2. Regression of Aggregate Patterns 40
 - 7.3. Cross-Sectional Patterns 43
 - 7.3.1. Firm Size 43
 - 7.3.2. Liquidity 46
- 8. Conclusions 50
- Appendices 52
- Sources 53

1. Introduction

Whenever payment does not occur simultaneously with the delivery of goods or services, the supplier is providing a short-term loan to the customer. This is called trade credit and it has been shown to be an important source of short-term financing for most firms. A fundamental aspect of trade credit is its two-way nature. Most firms, particularly those at an intermediate points in the value chains, both obtain trade credit from their suppliers and extend it to their customers. Trade credit thus represents a sizable component of both liabilities and assets. For example in the U.K. more than 80% of 'business to business' transactions are on credit terms (Wilson & Summers, 2002). Accounts payable clearly exceed short-term bank loans in manufacturing firms (Anatasova & Wilson, 2003). In the country's publicly listed companies, 70% of total short-term credit extended and 55% of credit received took the form of trade credit during 1983-1995 (Kohler et al., 2000).

It is not self-evident why industrial firms extend credit to their customers when there are institutions specialized in providing finance. A number of theories have tried to explain the phenomenon. These theories can be divided into two categories. First, several researchers have identified possible transaction motives for the use of trade credit. The motives vary by nature, but range from purely reducing transaction cost by making payments less frequently (Ferris, 1981), reducing informational asymmetries (Long et al., 1993; Ng et al., 1999; Smith, 1987) or gaining a mean to price discriminate (Brennan et al., 1988; Petersen & Rajan, 1997) to safeguarding an implicit equity stake in the customer firm (e.g. Smith, 1987; Petersen & Rajan, 1997).

The second group of theories is founded on the financing motive for the use of trade credit. These theories emphasize reasons that may cause a supplier to have a financing advantage over traditional lenders in providing credit to a customer. The advantage may arise from the supplier's superior position in monitoring (e.g. Mian & Smith, 1992; Jain, 2001) and controlling the customer (Petersen & Rajan, 1997; Cuñat, 2007), higher salvaging value of collateral (e.g. Mian & Smith, 1992; Frank & Maksimovic, 2005) or better knowledge of the market (Ng et al., 1999).

While the transaction motives imply the role of trade credit can differ between industries, firms or countries, it also points to the relatively stable nature of trade credit through business cycles. The financing motive on the other hand suggests the use of trade credit may vary

depending on the availability of other sources of financing. This idea forms the foundation for the trade credit channel theory, which suggests that during periods of restricted bank financing, e.g. during contractionary monetary policy, or in a more severe case, financial crisis, firms increase their use of trade credit (see eg. Kohler et al., 2000; Nilsen, 2002; Mateut et al., 2006). Thus trade credit may substitute traditional sources of financing. More specifically the theory suggests firms which are less vulnerable to a reduction in money supply, in terms of lower reliance to bank financing or lower likelihood of being credit rationed, redistribute financing to the more vulnerable firms as trade credit. Thus it is claimed that the substitution of bank credit with trade credit somewhat alleviates the asymmetric negative effects of credit rationing by banks during a tight money period.

The history of the trade credit channel theory extends back to the 1960s, when it was first suggested by Meltzer (1960). There exists an extensive literature on trade credit during tight monetary policy, which is concentrated in the developed financial markets, most notably the U.S. As far as I am aware, only two studies extend the research into financial crisis. These studies by Taketa and Udell (2007) and Love et al. (2007) show that the use of trade credit during a crisis may be more complex than the previous studies suggest. Taketa and Udell (2007) find some evidence of trade credit and bank credit acting as complements rather than substitutes during the Japanese banking crisis, but their aggregated data does not allow them to explore the finding in more detail. Love et al.'s (2007) study on six emerging countries during financial crises in the 1990s shows an increase in trade credit provided and obtained immediately after the crisis begins, as the trade credit channel theory would predict. But surprisingly they find that the amount of trade credit provided collapses in the aftermath of the crisis even though their sample only includes large, publicly traded firms, which are likely to be more resilient to crisis events.

Firms facing high and low agency costs have a different role in the trade credit channel. The most often cited proxy for agency costs is firm size. Any study focusing only on large firms is unlikely to capture the whole phenomenon. The main contribution of this study is that it broadens Love et al.'s (2007) work on trade credit channel during financial crises to include both large and small firms. Since the role of trade credit financing varies between countries and is more important in less developed financial and legal systems, studying whether Love et al.'s (2007) findings during crises periods also apply to developed financial markets is warranted. During the past years, the markets have witnessed a historically severe credit

crunch, which has affected the global financial centers the most. This offers a possibility to test the trade credit channel theory during a financial crisis in a background setting comparable to most of the studies during tight monetary policy. This study focuses on the U.K. because of the availability of firm level data from unquoted and small firms.

The use of trade credit is studied using fixed effects panel regression model. The research period ranges from 2004 to 2008. The last two years of the sample represent crisis years, which are compared against the previous years of normality within firms. Although most readers are likely to be aware of the progress of the crisis during the period, Figure 1 justifies why years 2007 and 2008 are characterized as crisis years.

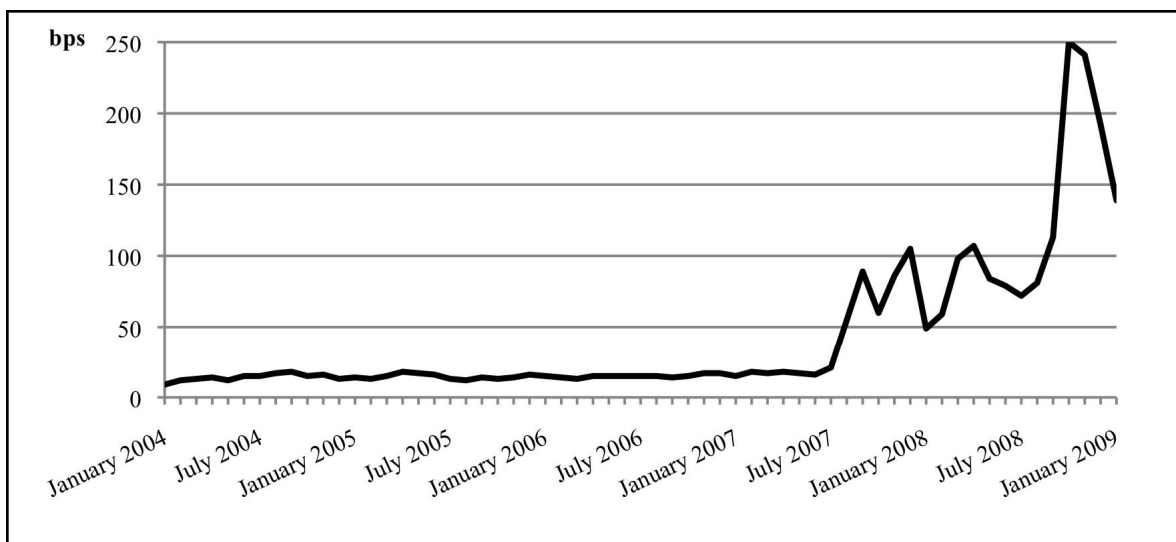


Figure 1. 3-Month LIBOR Spread

The figure shows the monthly average 3-month London interbank lending rate (LIBOR) spread over the monthly average rate of discount for 3-month UK treasury bills. Both rates are based in sterling (GBP).

Source: Bank of England

The global credit boom peaked in mid-2007, following a meltdown of subprime mortgages in the U.S. Lack of transparency of securitized products, and who were holding them, raised concerns about the solvency of financial institutions drying out interbank financing and triggering a liquidity shortage. The crisis spread quickly to Europe. The U.K. banking sector, which includes large internationally active banks, was hit especially hard. Figure 1 shows how the spread in sterling 3-month interbank lending rate was reasonably flat during the research period, varying from 9 to 18 basis points, until July 2007 when the sub-prime mortgages started to erode trust between banks. After this the spread increased significantly, reaching an average of 102 basis points during the rest of the research period. In mid-

September 2008 the collapse of Lehman Brothers in the U.S. caused a full-blown banking panic increasing the spread even further. The highest average monthly spread (250 basis points) is reported for October 2008, before the government rescue operations eased the panic in the market. The government and Bank of England introduced a number of policy measures to forestall a systemic breakdown. The initial rescue package was launched in October introducing large-scale guarantees of bank liabilities and an initial round of capital injections to Lloyds/HBOS and Royal Bank of Scotland. Around the same time the Bank of England expanded its special liquidity scheme, eased collateral requirements on open market operations and revamped its emergency lending facilities.

Since the summer of 2007 banks sought to restructure their balance sheets through new capital, selling assets and reining back their lending to the private sector. The results of the Credit Conditions Survey by the Bank of England indicate that lenders reduced the availability of credit to businesses between Q3 2007 and the end of 2008 (Bank of England, 2009b). The Agents of the bank also conducted surveys throughout the crisis. In November 2007 nearly half of the respondents reported credit conditions had tightened (Bank of England, 2007), while their share grew by approximately 10 percentage points till September 2008 (Bank of England, 2008a).

The purpose of this thesis is to study the changes in trade credit use when bank credit is limited. Most of the previous literature suggests firms should both provide more trade credit to their customers and obtain more trade credit from their suppliers (Hypothesis 1), but the results by Love et al. (2007) imply that the trade credit dynamics may not be this straight forward during a crisis. This study also aims to answer whether firms' vulnerability to the crisis affects the possible change in their use of trade credit. The hypothesis is that firms, which are more vulnerable to the crisis, increase trade credit obtained from their suppliers more than less vulnerable firms (Hypothesis 2). On the contrary, it is expected that firms, which are less vulnerable to the crisis, increase provision of trade credit to their customers more than more vulnerable firms (Hypothesis 3).

There are differences in the research settings of this and earlier studies that may influence the results. The trade credit channel theory has not been previously tested in developed markets during a financial crisis. In addition to the different level of financial and legal system development in the studied countries, the inclusion of small firms in the sample separates this

study from Love et al.'s (2007) work. The severity and global reach of the credit crunch during the research period may also impact the results in a way, which cannot be fully anticipated in light of the previous literature.

This study shows evidence that firms' trade credit use behaves very differently during a crisis than during periods of tight monetary policy. The main finding is that firms both obtain less trade credit from their suppliers and provide less trade credit to their customers in 2008. The result is robust and significant at the 1 % level in all of the statistical models in this study. This finding partly supports Love et al.'s (2007) results of a decreasing trade credit provision after early stages of a financial crisis, but unlike Love et al., this study is unable to find any evidence of a trade credit channel at any time during the crisis. The results also show a decrease in both trade credit obtained and provided.

The empirical analysis offers only very limited support for characterizing year 2007 as a crisis year. The results imply trade credit is used in a similar manner in 2007 as during the control years, although there are some weak and unrobust results of a marginal reduction in aggregate trade credit provision already in 2007.

Analysis of the possible factors attributing to the decline in trade credit use provides only little additional insight. The most often used proxy for financing constraints, firm size is positively related to trade credit provision, but the effect is small in magnitude and its statistical significance becomes low when control variables are added to the regression model. The results show some evidence though, that larger firms decrease their trade credit provision less than smaller firms, which would seem to imply they are less vulnerable to the crisis, but still somewhat affected. This conclusion is supported by the results that size is also positively related to trade credit obtained during 2008. Thus it seems unlikely the reduction in trade credit use is caused by a lower demand for trade credit and a more plausible explanation appears to be a reduction in trade credit supply. However, since the results are limited, further studies are needed to find out why a trade credit channel does not exist during a crisis.

In regard to other proxies for the vulnerability to a crisis, this study is unable to yield any results. Liquidity is found to be negatively associated with trade credit received in general, but the results do not support the hypothesis of a particular relationship in a crisis.

The remainder of this thesis is organized as follows. First, Chapter 2 discusses previous literature on the transaction and financing motives for the use of trade credit, following by an

introduction to the trade credit channel theory. Chapter 3 provides a brief overview of trade credit practices in the U.K. before the hypotheses are presented in Chapter 4. Chapter 5 moves on to the methodology explaining panel regression analysis first generally and then the regression models used in this study more specifically. After methodology, Chapter 6 describes the data. Results are presented in Chapter 7 before concluding in Chapter 8.

2. Theoretical Background

Whenever payment and delivery of goods or services do not occur simultaneously, payment arrangements are, in effect, credit terms. Trade credit is widely used across industries and geographical areas. It is not self-evident why industrial firms engage in lending to their customers when there are traditional lenders who are specialized in assessing credit risk, financing and collecting receivables.

Several theories try to explain the use of trade credit. These theories can be divided into two groups. While some focus on transaction motives, others emphasize financial motives for the use of inter-firm financing. The theories are not mutually exclusive and few of them can explain the use of trade credit in all types of transactions its use is witnessed in reality. Most likely several reasons play a role simultaneously and with different weights in different transactions. For example, Elliehausen and Wolken (1993) estimate that for the small U.S. firms in their sample, the financing component is two-fifths to one-half the size of the transaction component, and both motives appear to be economically significant determinants of trade credit use.

This chapter covers the most plausible theories of both transaction and financing motives. The last sub-chapter introduces the bank lending and trade credit channel theories, and discusses how they relate to the financing motives.

2.1. Transaction Motives

The simplest explanation for the use of trade credit is that it reduces the transaction costs of paying bills. Rather than making payments daily, a firm can accumulate obligations and pay them less frequently. This also enables the firm to separate the payment cycle from the delivery schedule, make cash flows more predictable and reduce the level of precautionary cash holdings (Ferris, 1981). Firms with variable demand can also use credit terms instead of price to deal with the fluctuations (Emery, 1984; Long et al., 1993).

In addition to the explanations based on the ability to manipulate the timing of payments, researches have identified three main transaction motives that may explain the use of trade credit. The motives stem from asymmetric information between the seller and the buyer, from an incentive to price discriminate and from the seller's implicit equity stake in the buyer firm.

2.1.1. Asymmetric Information between the Supplier and the Customer

Trade credit can reduce the transaction costs arising from asymmetric information between the supplier and the customer. Seller-provided guarantees and reputation can reduce concerns about product quality while buyer reputation and credit rating can reduce concerns about non-payment. Reputation-based approaches are not complete solutions though, especially when trading partners are new, small or distant from each other (Ng et al., 1999). Payment terms can be used to address the problems arising from asymmetric information. First, a supplier who lacks sufficient reputation or whose products require more time to observe quality can extend trade credit so that buyers can verify product quality before payment (Long et al., 1993). In this sense trade credit is an effective guarantee. Second, specific terms (e.g. early payment discounts) can enable customers to reveal credit quality through their payment practices (Smith, 1987).

2.1.2. Price Discrimination

Trade credit may also be used to price discriminate. Credit terms are usually invariant to the credit quality of the buyer, and thus trade credit reduces the effective price to low-quality borrowers (Petersen & Rajan, 1997). Brennan et al. (1988) show theoretically that when there is low competition in the product market, suppliers have an incentive to price discriminate between cash and credit customers. This is possible when the reservation price of credit customers or demand elasticity are lower than that of cash customers or if there is adverse selection in the credit market.

Another way of seeing the price discrimination motive is to think of firms having a high margin between sales and variable costs. These firms have an incentive to make additional sales without cutting the price to their existing customers. Antitrust laws often prevent direct price discrimination, but high-priced trade credit may be used as a subsidy targeted at risky customers. Creditworthy customers will find the trade credit overpriced and pay immediately while risky customers will find it worthwhile to borrow because trade credit may still be cheaper than their other sources of finance (Petersen & Rajan, 1997).

2.1.3. Supplier's Implicit Equity Stake in the Customer Firm

A supplier might not discriminate in favour of the risky customers solely to support sales in the short-term. It may have a long-term interest in the survival of the customer firm. The

supplier then considers not only the net profit margin on the current sales but also the present value of the profit margins on future sales to the same customer. In other words, the supplier may have an implicit equity stake in the customer, especially if it has few substitutes for the buyer or it has made a non-salvageable investment in the relationship (Smith, 1987; Petersen & Rajan, 1997).

Huyghebaert et al. (2001) argue that because of their implicit equity stake, suppliers also adopt a more lenient liquidation policy for defaulting firms than banks, which hold a much smaller implicit equity stake in their borrowers. Thus entrepreneurs who value control rights may limit their bank borrowings and take up granted trade credit. Huyghebaert (2006) offers empirical evidence for the argument by showing that when ownership of a start-up company is highly concentrated in the hands of the entrepreneur, firms borrow more from their suppliers.

The transaction motives suggest trade credit is offered when informational asymmetries between the supplier and the buyer are high, when demand is variable or when the supplier has high sales margins or a high level of specialized investment at stake. The theories raise several hypotheses. For example they propose that trade credit terms vary across industries and that young and small firms offer more trade credit than established and large ones. The transaction motives also suggest trade credit is reasonably stable over time.

2.2. Financing Motives

The proponents of the financing motives explaining the use of trade credit argue that if trade credit simply existed to minimize transaction costs, then we should have witnessed a long-term decline in trade credit use due to the many improvements in transaction technologies that have taken place. Such a trend has not occurred, which seems to suggest there must be more to the use of trade credit (e.g. Frank & Maksimovic, 2005).

This chapter explains how the financing motives are based on asymmetric information between banks and firms, which may create a financing advantage to the supplier. If banks are not willing to lend to some firms but suppliers are, then trade credit may substitute bank credit in the financing mix of credit rationed firms. However, it seems trade credit comes behind bank credit in the financing 'pecking order'.

2.2.1. Suppliers' Financing Advantage over Banks

While the transaction motives may stem from informational asymmetries between sellers and buyers, the financing motives are based on asymmetric information between banks and firms. This asymmetry may preclude financing of valuable projects. Biais and Gollier (1997) offer a theoretical model, which explains how trade credit can alleviate this problem by incorporating in the lending relation the private information held by suppliers about their customers. The private information gives the supplier a financing advantage over traditional lenders in investigating the credit worthiness of the customer, as well as a better ability to monitor and force repayment of the credit.

The financing advantage can come from at least four sources. First, a supplier may have lower monitoring costs than a bank. It can gather information as a by-product in the normal course of business from e.g. the timing and size of the customer's orders and the buyer's inability to take advantage of early payment discounts. Thus the supplier may be able to get the information faster and at lower cost than a traditional financier (Mian & Smith, 1992; Petersen & Rajan, 1997; Jain, 2001). Jain (2001) argues that both the bank and the seller are better off when the bank lends to the seller with superior information, which intermediates the loan to the buyer as trade credit. However, the buyer loses since it pays a higher interest rate than on direct loans from the bank.

Second, the supplier can have an advantage in salvaging value from existing assets. If the buyer defaults, the supplier can seize the goods supplied. The more durable the goods are, the better collateral they make. Financial institutions can also reclaim the firm's assets to pay off the loan. However, because the financial institution lacks the network and expertise for selling the goods, the supplier's costs of repossessing and reselling are likely to be lower (Mian & Smith, 1992; Frank & Maksimovic, 2005; Petersen & Rajan, 1997). In many jurisdictions trade credit is junior unless it is secured (Fabbri & Menichini, 2010). Longhofer and Santos (2003) argue this maximizes social welfare. When the collateral value of the supplied goods is higher for the seller than for banks, giving trade creditors a security interest in the assets, while subordinating the rest of their claim, benefits both the trade creditors and other debt holders.

Third, the supplier may have an advantage in controlling the buyer especially if the buyer is dependent on the supplied goods, has few alternative sources for the goods and the customer

does not make up a large share of the supplier's sales. In these cases, the threat of cutting off future supplies can be more effective and immediate than the threat of cutting of future finance (Petersen & Rajan, 1997; Cuñat, 2007).

And last, the supplier may have an informational advantage because of superior knowledge of the market. Conducting business with a network of similar buyers may help the seller to distinguish between a customer who is in financial trouble and a general decline in the market (Ng et al., 1999).

2.2.2. Substitution of Trade Credit and Other Sources of Financing

The financing advantage means firms may be more willing to offer trade credit to their customers than financial institutions are to lend to the same firms. Several theories suggest trade credit and other sources of financing can be substitutes. Huyghebaert's (2006) study shows that start-ups use more trade credit when financial constraints are large. Petersen and Rajan (1997) study small firms in the U.S. and find that firms use more trade credit when credit from financial institutions is unavailable. Their results also suggest firms with better access to traditional financing offer more trade credit. Similar results are found in a study with a large sample of public and private firms in the U.K., which shows demand for trade credit decreases with both institutional finance and internally generated funds (Atanasova, 2007). These studies suggest trade finance is lower in the 'pecking order' (Myers & Majluf, 1984) than both internally generated cash and institutional borrowing.

The position in the pecking order is claimed to be a consequence of the relatively high cost of trade credit. Huyghebaert et al. (2001) and Wilner (2000) argue that because of their more lenient liquidation policy and willingness to grant more concessions to customers in financial distress, suppliers attract the higher risk debtors. Thus the higher price of trade credit reflects the higher credit risk.

However, most firms use both trade and bank credit instead of resorting to trade credit only after other cheaper sources of financing are no longer available. Biais and Gollier (1997) explain that suppliers have private information about their customers, which is signalled to bank creditors through the use of trade credit. In their model, the availability of trade credit facilitates the access to relatively cheap bank credit, and thus they suggest trade credit may also complement bank credit. Burkart and Ellingsen (2004) present a similar argument. They claim that the source of supplier's informational advantage is the input transaction itself.

Suppliers regularly lend inputs, but they rarely lend cash. While cash can be easily diverted, i.e. used in a way, which does not maximize the lender's expected return, most inputs are harder to divert. The result of their model is that the availability of trade credit increases the amount that banks are willing to lend, because banks anticipate that the available trade credit boosts investment rather than diversion.

Although trade credit is typically considered to be relatively expensive, this assumption has also been debated. Two-part credit terms (i.e. early payment or cash discounts) are relatively common in supplier financing. The interest rates implicit in these arrangements are in most instances considerably higher than the interest rates on loans for working capital charged by financial institutions. When trade credit is used at the cost of discounts it is very expensive in comparison to institutional finance. It may, however, be perceived to be cheaper because the transaction costs of obtaining trade credit are less than of obtaining institutional financing. Arranging credit requires time and effort and a large part of these costs are fixed. The combination of interest and transaction costs may make closed-end credit from financial institutions seem more expensive than trade credit for meeting recurring needs for working capital, especially if the amount of credit needed is small (Elliehausen & Wolker, 1993). Thus it has been argued that smaller firms will perceive trade credit to be cheaper than institutional credit and may prefer to use trade credit and late payment rather than bank debt (Howorth & Reber, 2003).

Trade credit may become even cheaper if penalties for late payment are not enforced, as often happens (e.g. Pike & Cheng, 2001; Wilson & Summers, 2002). However, especially since firms frequently pay late, a charge for late payment can be included implicitly in the price of a product. In fact, Howorth and Reber (2003) find no evidence that firms, which are categorized as habitual late payers, would take advantage of the lax late payment penalty practices. On the contrary, they find that habitual late payment is used at the high cost in the form of forgone discounts by companies, which have more difficulties obtaining finance than companies always or frequently paying on time. This result supports the suggestion that trade credit comes behind institutional borrowing in the 'pecking order'.

Studies on less-developed financial markets also support the substitution of formal credit to trade credit. Ge and Qiu's (2007) compare state owned and non-state owned firms in China and find non-state owned firms, which have limited access to bank credit, obtain more trade

credit than state owned firms. They also show this higher use of trade credit is primarily for financing rather than transactional purposes.

Frank and Maksimovic (2005) suggest that in developing economies, where credit is scarce, it may be efficient for suppliers to act as financial intermediaries. The buyer must raise more than the seller to finance the transaction since the buyer needs to raise both the production costs and the seller's profit. When extending trade credit, the seller only needs to raise the production costs and the profit-component can be self-financed. Fisman and Love (2003) offer further evidence that trade credit has an important role in developing markets. They show that in countries with weaker financial institutions, industries with higher trade credit financing exhibit higher growth.

Demirgüç-Kunt and Maksimovic's (2001) study also links the development of a country's banking system and legal infrastructure with the use of trade credit. Their results show that firms rely more on trade credit relative to bank credit in inefficient legal systems. The researchers explain that the suppliers have a comparative advantage to use unofficial mechanisms for extracting payment. They also find that the development of the banking system and the use of trade credit are complements rather than substitutes. This seems to imply that non-financial firms need a somewhat functioning financial system in order to act as financial intermediaries.

2.3. Trade Credit Channel

While the transaction motive suggests the use of trade credit is stable over time, the financing motive, and the following substitution of institutional borrowing and trade credit, imply trade credit may have a varying role through time, depending on the availability and price of other sources of financing.

The bank lending channel theory argues that during tight money periods, i.e. monetary contractions, banks restrict lending to some firms, thus reducing their desired investment independently of interest rates (Nilsen, 2002). Banks tend to cut off lending to firms facing high agency costs (flight to quality) and thus downturns differentially affect the real economic activity of high-agency-cost borrowers (Bernanke et al., 1996). The informational frictions, that add to the cost of external finance, apply mainly to younger firms, firms with high degree of idiosyncratic risk and firms that are not well collateralized (Gertler & Gilchrist, 1994). These high-agency-cost borrowers, which are more likely to be credit rationed, are on average

smaller firms (e.g. Meltzer, 1960; Gertler & Gilchrist, 1993, 1994; Oliner & Rudebusch, 1996).

Meltzer (1960) was the first to show that when money is tightened, firms with relatively large cash balances increase the average length of time for which trade credit is extended. This seems to favour the firms against whom bank credit rationing is said to discriminate. When the shock that causes the premium to rise for firms dependent on banks does not raise the cost of financing as much for firms providing the trade credit, a trade credit channel might be a substitute for the bank lending channel (Kohler et al., 2000). Although this proposition has later been contested (e.g. Gertler & Gilchrist, 1993; Oliner & Rudebusch, 1996), several studies have also found supporting evidence. Ramey (1992), for example, studies the fluctuations in money and trade credit and finds that they are negatively related in both the short and long run. Nilsen's (2002) study shows that small firms increase their use of trade credit during contractionary monetary policy episodes. But Nilsen finds also large firms increase their trade credit obtained. When studying large firms in more detail, he finds that firms without a bond rating, firms that are cash rich and firms lacking collateralizable assets use trade credit similarly to small firms. This result implies not only small firms but also some large ones are potentially credit rationed and lack other financing alternatives to trade credit.

Nilsen's (2002) evidence that cash-rich firms use more trade credit is slightly puzzling and in contradiction with findings in certain other studies (e.g. Ramey, 1992; Love et al., 2007). Nilsen hypothesizes that firms may hold large cash reserves as a precaution because they lack access to the financial market and that they are also likely to have more volatile cash flows. His explanation is consistent with the findings of Calomiris et al. (1994), which suggest that in contrast to high credit quality commercial paper issuers, lower quality firms face financing constraints that lead them to accumulate 'buffer stocks' of liquid assets. They also find evidence that commercial paper is used to finance accounts receivable at the onset of a recession, and that firms with better access to short-term credit provide financing to lower quality firms, when the latter are hit with an unanticipated increase in inventories due to a change in the business cycle.

The problem with the studies done in the U.S. is the lack of firm level data for small firms. Most researchers either concentrate on large firms or use a semi-aggregate data from the quarterly financial reports (QRF) published by the U.S. Census Bureau, which categorizes firms based on their asset size. Mateut et al. (2006) study firm-level data from British firms in

1990-1999. They show that during tight monetary policy, bank loans decline in absolute and relative terms and trade credit increases. They also find that it is the small firms that are excluded from bank loans and resort to trade credit. These results hold even when they take into account the effects of solvency, firm age, credit rating, sales and demand side effects. De Blasio (2005) studies Italian manufacturing firms. His study shows that firms substitute bank finance with trade credit during monetary tightening, but also that this substitution effect is small and the use of trade credit should primarily be explained with time invariant transaction motives.

Most of the studies on the use of trade credit as a substitute for bank financing in developed financial systems concentrate on the changes in trade credit use during monetary contractions. However, central bank money tightening does not represent the most severe source of reduction in the supply of money. Taketa and Udell (2007) study lending channels in small and medium size firms during the Japanese financial crisis. Their results show both trade credit and short-term bank credit increasing during the crisis¹, and thus offer some evidence that, against their hypothesis, trade credit and financial institution lending are complements rather than substitutes during a financial crisis. They can however only study the phenomenon in the balance as their data is aggregated in three size groups. They thus cannot study whether the use of trade or bank credit during a crisis depends on the financial characteristics of individual firms or show that the two are truly complements (i.e. that same firms increase both their use of trade and bank credit).

Love et al. (2007) study the effects of financial crises on trade credit in six emerging economies, mainly in Asia. They find an increase in the amount of trade credit obtained and provided immediately after the crisis. Interestingly, they also find that after the early stages of the crisis, the provision of trade credit contracts in the following months and years. Their sample only includes the largest firms in each country, but their results suggest firms that are likely to be more vulnerable to the crises (in terms of liquidity and reliance on short-term bank debt) extend less trade credit to their customers. They argue that the decline in the aggregate trade credit ratios is driven by the reduction in the supply, rather than demand, of trade credit that follows a bank credit crunch.

¹ There is some dispute whether the banking crisis in Japan was accompanied by a credit crunch. Local market peculiarities and government actions during the crisis may have prevented a credit crunch, even though the banking sector was in crisis, or the credit crunch may have been limited to the private banking sector while the public sector increased lending, cancelling out the private sector crunch in the aggregate (Taketa & Udell, 2007).

A profound complexity in studying the use of trade credit is the difficulty to detect demand driven causal relationships from supply driven causalities. From the theoretical perspective it is easy to argue for an increased demand of trade credit by firms that become credit rationed by banks during a tight money period. But studies on the trade credit channel rarely explicitly state, why firms with continued access to institutional financing increase their provision of trade credit to customers. The tacit assumption is that firms use their financial strength to support profitable business opportunities.

Even though the trade credit channel theory depicts firms as financial intermediaries, it does not discuss the risk-reward relationship that firms need to consider when they provide financing. Pike and Cheng's (2001) survey study on large U.K. firms shows that the overriding goal of the credit function in firms (77% of respondents) is to minimize risk, particularly in terms of protecting accounts receivables. Other goals, such as profits and sales, are generally viewed as of secondary importance. Both times of monetary contractions and financial crises tend to coexist with increased probability of customer's default. This may lead to a reduced supply of trade credit even if the seller has financial resources to provide it.

The reduction in the willingness to provide trade credit could potentially be scaled up by the often simultaneously reducing possibilities to transfer credit risk to third parties through credit insurance or factoring. Especially trade credit insurance is a widely used risk management tool, for example 38% of respondents in Pike and Cheng's (2001) study employ trade credit insurance regularly while 5% enter into factoring or invoice discounting arrangements. However, the study only includes large firms, which are on average less likely to use factors than smaller firms (Summers and Wilson, 2000). In the U.K. more than 40,000 companies used invoice discounting or factoring services in 2008. A year earlier there were 13,700 credit insurance policies covering turnover equivalent of 10% of the country's GDP (Bank of England, 2009a).

Tsuruta (2007) offers empirical evidence that when non-financial firms act as financial intermediaries, the market exhibits similar phenomena than traditional financial markets. At times when credit contagion is a problem, if a firm suffers from an unanticipated liquidity shock and defaults, the effect of the shock spreads to the firms that have financial claims on the defaulting firm. Tsuruta's (2007) study on Japanese companies shows that during a recession, suppliers reduce trade credit more for manufacturing firms with high trade

receivables irrespective of how risky the firms otherwise are. Knowing this some firms may become more cautious in their provision of trade credit during uncertain economic periods.

3. A Brief Overview of Trade Credit Use in the U.K.

This study focuses on the use of trade credit in the U.K. during the recent financial crisis. Before presenting the hypotheses, which are based on the theory and existing empirical evidence of the trade credit channel, the trade credit practices in the U.K. are briefly described as well as some indicative implications of the recent financial crisis on trade credit.

Trade credit is very widely used in the U.K. with a common estimate being that more than 80% of daily 'business to business' transactions are on credit terms. Trade receivables is one of the main assets on most corporate balance sheets, representing up to 30-35% of total assets, on average, for all companies. Predominantly, the payment period specified is 30 days (net 30 days or 30 from the end of month), but it can vary from less than seven days to over 120 days. (Wilson & Summers, 2002).

However, the effective trade credit period is on average significantly longer than the specified payment period. Pike and Cheng's (2001) survey study on 154 large firms in the U.K. shows that although normal credit terms are 30 days, cash collection period is typically between 45 and 60 days. Wilson and Summers' (2002) survey on 500 small companies concludes that on average 40% of invoices are paid late, but less than 10% of suppliers enforce interest charges on late payments. The lenient attitude towards late payment is not restricted to small companies with potentially weak bargaining and enforcement power, since only 44% of the large companies surveyed by Pike and Cheng (2001) had ever exercised their right to charge interest on overdue debts and just 3% exercised interest charges as a standard practice. This is even though two-thirds of the respondents incorporate the right to charge interest within their standard credit conditions.

The surveys also show firms sometimes adjust payment terms based on their customers. Although approximately 80% of the firms in Pike & Cheng's (2001) study offer trade credit to virtually all customers, almost half of them regularly require high-risk companies to pay prior-delivery, either in full or in part. Wilson and Summers' (2002) results indicate that the greatest motivation for varying credit terms is related to credit being used as a competitive tool (i.e. attracting and retaining customers and new large orders or contracts). They also find that another important motivation to vary credit terms is to improve cash flows or to help existing customers through cash-flow difficulties.

In the U.K., suppliers can include a Retention of Title clause in the sales contract, allowing them to reclaim all the goods supplied on credit in case of bankruptcy, as long as they are distinguishable from other suppliers' goods (Fabbri & Menichini, 2010). From the small firms surveyed, 50% retain ownership of goods until they are paid for, but only 22% indicated that they would reclaim goods in the event of default (Wilson & Summers, 2002).

To my knowledge, no scientific research exists to date of the impact of the financial crisis to the use of trade credit in the U.K. However, a credit insurance company Atradius has published several survey results on the recent payment behaviour of companies. The Agents of Bank of England have also conducted survey studies with partial relevance to trade credit use during the crisis.

In the Winter 2008/2009, firms were asked how much access to financing affects the ability of their customers to pay and to estimate the same five years earlier. The results for U.K. respondents show that access to financing had clearly grown in importance. When only 10% of respondents said the factor had a significant impact five years earlier, 26% were of the opinion in the turn of 2009. On the other end, only 28% viewed the accessibility of financing to play no or only a small role in their customers' ability to pay, while a high 62% held the opinion five years earlier. In a recession firms are more likely to face cash-flow constraints, for example because it takes longer than expected to sell stocks. Consequently another major factor that had grown in importance in the survey responses was customers' cash flows. At the time of the survey, 46% estimated cash flows to have a significant impact on the customers' ability to pay, while only 24% held the same view five years earlier (Atradius, 2009a).

The survey results highlight how the credit conditions in the end of 2008 and early 2009 were out of ordinary. However, it is less clear, how this affected firms' use of trade credit. In a survey conducted in August 2009, 38% of U.K. respondents replied that the economic crisis had no effect on how business was made in regards to sales on credit terms. The rest of the responses were divided, 37% saying the crisis had caused an increase in the sales on credit while 28% had witnessed a decrease. Approximately half of the same companies had seen no change in the availability of credit from their own suppliers, while 26% said there had been an increase and 23% mentioned a decrease (Atradius, 2009b).

The survey responses show some evidence that firms became more cautious of whom to extend trade credit during the crisis. Almost half of the U.K. firms had increased the frequency they review buyers' creditworthiness and 44% had begun using or were considering using advance payments to minimize risk of payment default (Atradius, 2009b).

Bank of England (2008b) reported in late 2008 that companies were finding it difficult to protect themselves against the risks associated with extending credit to their trading partners. A survey on about 300 firms from a range of firm sizes shows trade credit insurance is very widely viewed as relevant to business, and almost half reported a tighter credit insurance environment. A substantial minority of the respondents also claimed the time taken to receive payment for goods and services had increased and around 45% reported some increase in bad debts. Firms were responding to these changes in trade credit quality and availability of insurance together with tighter short-term bank financing mainly by cutting back on capital expenditure and focussing on cash management. An interesting detail is that about a quarter of the respondents had refused orders as a direct result of tighter working capital.

4. Hypotheses

This study seeks to answer two key questions. First, does the use of trade credit change when bank lending is limited? And second, does the firm's vulnerability to the crisis affect the change in the use of trade credit? Three hypotheses arise from the previous literature and are discussed in this chapter. The hypotheses are based on the trade credit channel theory, as existing research on trade credit use during financial crises is still extremely limited.

There are differences in research settings, which may affect the results to differ from the earlier studies. Love et al. (2007) already show that the results obtained from times of monetary contraction may not apply to more severe credit crunches during financial crises. But although this study is similar to Love et al.'s (2007) in the respect the research period covers a financial crisis, the studies differ in other aspects, which may influence the results.

First, the most important contribution of this study in relation to Love et al.'s (2007) work is a firm-level data, which includes not only large but also small companies. The abundance of previous studies, which emphasize the different standing of large and small firms during tighter credit conditions, underscore that in order to observe the phenomenon in full, the data needs to be versatile in terms of firm size.

Second, Love et al. (2007) study the use of trade credit in emerging markets which have less developed financial and legal systems than the U.K. Earlier literature suggests trade credit plays a smaller role relative to bank credit in countries with developed financial and legal institutions. When bank credit is limited, the elasticity of trade credit might not be as high as in countries where trade creditors in general have a greater financing advantage. There are no prior studies from developed financial markets under a period of such a severe credit crunch as has been witnessed recently, and thus no direct point of comparison exists.

A third, and a more arbitrary difference in the research settings is that during the financial crises in Love et al.'s (2007) study, the problems were limited to one or a few countries. As their data includes only large and publicly traded firms, this makes their results of the decreasing provision of trade credit even more puzzling. The best of the firms in their sample may not only be less affected by the domestic crisis, but also have access to international financial markets, which could limit their exposure to the credit crunch in the domestic market. The large companies are also likely to trade with foreign companies, and although

highly speculative, the results by Love et al. (2007), which show trade credit provided decreases in the aftermath of the crisis while trade credit obtained does not, could point to a trade credit channel from abroad. During the research period of this study, the crisis was global, or at least affected all the financial markets the firms in the sample would have access to, and where their possible important foreign trade partners would operate in. This could cause the effects of the crisis to be even more severe, and to touch a wider set of firms. As the trade credit channel is based on financially unconstrained firms intermediating bank credit to their constrained customers, an extensive credit crunch could potentially prevent the trade credit channel from working. This could explain why survey studies during the crisis in the U.K. do not indicate any evidence of a trade credit channel (Atradius, 2009b; Bank of England, 2008b).

Notwithstanding the doubts presented above, the following hypotheses are based on the traditional propositions of the trade credit channel theory and the existing empirical evidence.

H1. In a financial crisis, firms both provide more trade credit to their customers and obtain more trade credit from their suppliers.

The first hypothesis stems from several earlier studies (e.g. Nilsen, 2002; Mateut et al., 2006), which test how monetary contractions affect the use of trade credit. The findings by Love et al. (2007) imply the results may be more intriguing than the hypothesis suggests. Their results would suggest that at the wake of the crisis, both trade credit provided and received increase, but that trade credit provided later decreases as the crisis continues. The researchers argue this is caused by a reduction in the supply rather than the demand for trade credit financing. They claim that at some point in a crisis, bank lending is cut to the extent that its redistribution through the trade credit channel no longer works.

Even though it is not possible to pinpoint the causal effects in the supply or demand side², it is possible to reveal implications to one way or another. These implications are likely to arise when the second research question, concerning how the vulnerability to the financial crisis affects the use of trade credit, is addressed.

H2. Firms with higher vulnerability to a financial crisis obtain relatively more trade credit from their suppliers during the crisis than firms, which are less vulnerable.

² See Chapter 5.3 for discussion on the supply and demand side dependence.

This hypothesis is based on the bank lending channel theory and the idea of bank credit and trade credit as substitutes. Firm size and liquidity are tested as a proxy for firm's vulnerability to the financial crisis. Small firms are likely to face higher agency-costs in bank lending and thus be bank credit rationed during a crisis. Firms, which rely heavily on short-term bank loans or have a weaker liquidity, are more dependent on bank financing, which increases their vulnerability to the crisis.

H3. Firms, which are less vulnerable to a financial crisis, provide relatively more trade credit to their customers during the crisis than firms with higher vulnerability.

Meltzer (1960) was the first to suggest the third hypothesis already in the 1960's. He finds that firms with large cash balances are more likely to increase net trade credit (defined as trade receivables net of payables) faster than sales when monetary policy is tight. The story behind the hypothesis is that firms with better access to bank credit or strong liquidity work as financial intermediaries during a crisis channelling financing to the weaker firms in the form of trade credit. Although this is an antithesis to the second hypothesis, the sample in this study does not form a closed system, and thus the two hypotheses do not automatically hold in tandem. Different measures of the vulnerability to a crisis may also explain the changes in the provision and obtaining of trade credit during the crisis.

Table 1 summarizes the expected relationships between trade credit and the explanatory variables under interest.

Table 1. Hypotheses

Independent variable	Dependent variable	
	Trade credit obtained	Trade credit provided
Year 2007	+	+
Year 2008	+	+/-
Firm size during the crisis	-	+
Liquidity during the crisis	-	+

The table summarizes the hypothesized relationships between dependent and independent variables. The hypotheses are based on the theory and prior empirical evidence of the trade credit channel. The possible negative relationship of the year 2008 and trade credit provided follows the findings of Love et al. (2007).

5. Methodology

The interest of this thesis is in changes in firms' use of trade credit during a financial crisis. In order to study this, the data needs to be two-dimensional, i.e. contain observations on N different firms at T different time points. This type of data is called a panel data, or sometimes a longitudinal data or a cross-sectional time-series data.

Panel data may have group effects, time effects, or both. The emphasis of this study is in the within-firm variation, and thus the interest is in the group effects. The effects may be either fixed or random. We can make theoretical assumptions about the nature of the effects, but the best thing to do is to test that the model fits the data. Chapter 5.1 discusses the panel regression model and the difference between fixed and random effects.

A typical challenge with panel data models is that they are often plagued with misspecifications. As the data has both cross-sectional and time series dimensions, the model can suffer from both heteroskedasticity and autocorrelation. If either of these is present, and not corrected for, the results become unreliable. Testing for and correcting heteroscedasticity and autocorrelation in panel data models is discussed in Chapter 5.2.

While the first two sub-chapters are introduction to panel regression methodology in general, Chapter 5.3 explains the regression equations in this study that are employed to model the use of trade credit during the recent financial crisis in the U.K. The methodology in this study mainly follows the one used by Love et al. (2007).

5.1. Fixed Effects Panel Regression

Panel data has a set of units, e.g. firms ($i = 1, \dots, N$), each of which are measured at two or more points in time ($t = 1, \dots, T$). A basic framework of the panel regression model is:

$$y_{it} = \mu + \beta x_{it} + \alpha_i + \varepsilon_{it}, \quad (1)$$

where μ is an intercept, x is a vector of variables that vary over time and β is a vector of coefficients. The two error terms α and ε behave somewhat differently. There is a different idiosyncratic error term ε for each unit at each point in time but α only varies across the units. Thus α is treated as the combined effect on y of all unobserved variables that are constant over time.

There are three different types of effects, which determine the appropriate panel regression model. Pooled model is the most restrictive. It assumes no unobserved individual heterogeneity, i.e. α is constant for all units. As such it ignores the panel characteristics of the data, and a pooled model can be solved with basic ordinary least squares (OLS) regression. Theoretically a pooled model can be discarded as unsuitable for this study since it would require all firm-specific characteristics that are relatively stable over the research period (e.g. industry and characteristics of customer relationships) to have no effect on the use of trade credit.

The two other models, fixed effects and random effects, assume the existence of unobserved individual heterogeneity. Their difference is that the fixed effects model treats the unobserved individual specific variable as partially correlated with the observed regressors, while random effect models treat it as independently distributed of the regressors. Thus, the fixed effects methodology allows for any correlation between x and α . The inclusion of such correlation makes it possible to claim the fixed effects model controls for time-invariant unobservables. This property is perhaps the most important advantage in fixed effects models, because it makes it possible to control for all possible characteristics of the firms in a sample without measuring them, just as long as those characteristics do not change over time.

Fixed effect estimators are always consistent, but not necessarily the most efficient. Hausman's (1978) specification test is typically used to find out whether the more efficient random effects estimation also yields consistent results. If there is heteroskedasticity in the error terms, Hausman's test is invalid, but a test of overidentifying restrictions can be used to test for fixed vs. random effects (see Arellano, 1993). In the special case of homoskedastic errors, the test statistic is asymptotically equal to the Hausman specification test.

The trade credit model specifications are tested for overidentifying restrictions. With a few exceptions mostly in the simplest models, the Sargan-Hansen test statistics supports using the fixed effects model. Since the fixed effects are always consistent, the method is employed in all estimations. Using random effects for those models for which the test for overidentifying restrictions proves it suitable, would not affect the interpretation of the results.

There are two ways to estimate the fixed effects model, the least squares dummy variable (LSDV) estimation and the mean deviated model (also known as within effects). LSDV is perhaps intuitively more comprehensible as it is simply an OLS model, which includes $N-1$

dummy variables to distinguish the units in the data set. However, the estimation is computationally too expensive to run with large data sets. Thus in this study the fixed effects regressions are estimated using the mean deviated model:

$$y_{it} - \bar{y}_i + \bar{y} = \mu + \beta(x_{it} - \bar{x}_i + \bar{x}) + \varepsilon_{it} - \bar{\varepsilon}_i + \bar{\varepsilon} + \bar{\alpha}, \quad (2)$$

where \bar{y}_i , \bar{x}_i and $\bar{\varepsilon}_i$ are the averages of y_{it} , x_{it} and ε_{it} within i and \bar{y} , \bar{x} , $\bar{\varepsilon}$ and $\bar{\alpha}$ are the grand averages of y_{it} , x_{it} , ε_{it} and α_i . The LSDV and mean deviated model produce identical coefficient estimates and standard errors, but the measure of the overall explanatory power (R-squared) of the mean deviated model is deflated, and as such it is not reported in this study.

The problem with the fixed effects model is that most variables have both within- and between-unit variation. The relative magnitude of these determines the standard errors of the coefficients. Using the fixed effects model eliminates all of the between-unit variation and focuses on the within-unit changes. Thus, Fixed effects model is inefficient in estimating the effect of variables that have very little within variance, and it does not allow the estimation of time-invariant variables at all (Plümper & Troeger, 2007).

5.2. Cluster Robust Error Terms

Panel data models assume the error terms are homoskedastic (i.e. the estimated variance of the error terms is not dependent on the values of the independent variables) and serially uncorrelated (i.e. the error terms are not correlated with their own lagged values). However, this assumption is often violated in practice, which can lead to incorrect inference if the misspecification is not corrected. A modified Wald test for groupwise heteroskedasticity can be used to test if the residuals of a fixed effects regression model are heteroskedastic across units (Baum, 2001). A Wooldridge test is suitable for testing for serial correlation in panel data models. Drukker (2003) shows that the test has good size and power properties even when there is heteroskedasticity in the idiosyncratic error terms, the data is unbalanced and there are gaps in the individual series.

If there is heteroskedasticity and/or serial correlation, the estimators are still consistent but inefficient, and standard errors are biased. More specifically, the error terms can be severely deflated, resulting in Type I error (i.e. rejection of the null hypothesis when it is actually true). The misspecifications can be controlled by assuming ‘clustered errors’, i.e. that observations

within group i are correlated in some unknown way, but that groups i and j do not have correlated errors. This is often a reasonable assumption if units are randomly selected. Using clustered errors does not require knowledge about the dependence structure of observations within clusters. It allows the variance to be heteroskedastic, both within and between clusters, and it also allows for an arbitrary dependence structure among observations within a cluster (Williams, 2000; Wooldridge, 2003).

5.3. Statistical Models and Variables

This chapter focuses on the regression models used to study the potential change in the use of trade credit during a financial crisis. It also explains all variables included in the models. For clarity, a list of the variables is provided in Appendix A.

The research period ranges from 2004 to 2008. Years 2007 and 2008 are considered crisis years and the previous years are included to represent normality. One observation represents one firm in one year and crisis years are included in the study as binary variables. The interest is on the use of trade credit during the crisis years compared to its use during normal times. This difference is studied using the fixed effects regression with clustered errors.

5.3.1. Trade Credit Measures

The dependent variables are trade credit provided (TCP), trade credit obtained (TCO) and net trade credit (NTC). Trade credit provided is measured as trade receivables per sales, and trade credit payables per cost of goods sold (COGS) indicate obtained trade credit. The ratios cannot be directly interpreted. They are likely to capture both the percentage of goods sold or purchased on credit and the time for which credit is extended or received.

The third dependent variable is of less interest. It measures firms net trade credit, which is the difference between trade receivables and payables scaled by sales. The ratio reflects firms' relative willingness to extend trade credit net of the credit they receive themselves. Thus when a firm's NTC increases (decreases), it is providing more (less) trade credit to its customers relative to the trade credit it receives from its suppliers. Trade credit theories do not explicitly speak of net trade credit although the first study on trade credit channel (Meltzer, 1960) measured trade credit in net terms. At the aggregate it is unclear, how the theory predicts a crisis should affect the measure. Since firms are expected to increase both the trade credit they provide and obtain, the net result may be insignificant. However, we can imply

from the logic of the trade credit channel, that NTC should decrease (increase) for firms, which are (not) vulnerable to tight money periods.

Scaling short-term stock measures with flow measures can cause bias to the ratios, especially when the variables are from annual data. If the trend in sales or purchases has been significantly increasing or decreasing during the accounting year, the whole year flow figures may not represent the scale of operations at the end of the year. If the trend has been downwards (upwards), the trade credit variables may be skewed downwards (upwards). There is naturally likely to be between-firm variation in the growth trend during a year, but bias in relatively rare individual measures is not likely to reflect itself in the regression results. In relation to the sample as a whole, the potential bias in the trade credit measures is mostly of concern for the year 2008. The U.K. went into a recession in the second half of the year. While the country's GDP grew 0.7% during the whole year, the economy shrank 1.8% in the fourth quarter compared to the respective period a year before (IMF, 2009). Thus the likelihood of a dominant decreasing growth trend during 2008 is potentially large enough to bias the trade credit measures.

Interpreting trade credit provided and obtained is not straightforward. There are always two sides of trade credit, supply and demand. Based on data from financial statements, it is impossible to know for sure which side is causing the discovered patterns in the use of trade credit. Even if the results show the provision of trade credit increases, it can be caused by firms actually selling more on credit or providing longer credits or their customers increasing the time until payments are made while the actual credit terms stay constant. The same goes for increases in the trade credit obtained. It can be a result of a greater demand for trade credit financing or increase in the provision of trade credit by the suppliers. If firms become more reluctant to offer trade credit following a bank credit crunch, it may or may not show in the statistical tests depending on how their customers simultaneously adjust their use of trade credit financing.

5.3.2. Aggregate Patterns

Trade credit is first studied in the aggregate. Theories suggest there are a number of possible explanations for the general use of trade credit. Fortunately, causal variables that are either time-invariant or slowly changing over time (e.g. industry) should be captured in the firm fixed effects.

To control for possible causal variables that can vary significantly over time, three³ variables are included in the models to control for liquidity and size. The literature suggests trade credit comes behind internally generated funds in the pecking order, and thus cash-rich firms are likely to rely less on trade credit. They might also be willing to extend more trade credit to their own customers. Two proxies for liquidity are considered; cash flows scaled with assets (LIQ1) and the ratio of cash balance to assets at the beginning of the year (LIQ2). The statements of cash flows are available for only a minority of the firms in the sample, and thus cash flows are estimated as the sum of net income and depreciation for all firms.

Firm size can also influence the use of trade credit. Petersen and Rajan (1997) find larger firms obtaining significantly more trade credit than smaller firms, which is likely to be caused by transaction motives. It is less certain to which direction size affects trade credit provision. Smaller firms may provide more trade credit to their customers, because they are more likely to suffer from the problems arising from asymmetric information. On the other hand size gives firms economies of scale in receivable monitoring and collection and can add controlling power, which could decrease the costs of providing trade credit. Thus size can be hypothesized both to decrease and increase the provision of trade credit depending on which motive dominates.

Size changes only slowly through time, and thus it should be captured in firm fixed effects. As size is still not in fact constant, it is included in the model as a control variable. If it has very little within-firm variation, it should show up statistically insignificant. Because of the wide range in firm size in the sample, size is measured as the logarithm of total assets (SIZE).

³ Previous literature has found also other time-variant factors to influence the use of trade credit. As suggested by Atanasova and Wilson (2003), the demand for trade credit may depend on the presence of growth opportunities, which can be assumed to increase with sales growth. Growth opportunities are also likely to be lower for larger firms (Petersen & Rajan, 1997), and firm size is included as a control variable. Another factor, which may affect the demand for trade credit, is based on the maturity matching approach suggested in finance literature. Firms with more short-term assets are assumed to have a higher demand for short-term credit in general and trade credit in particular (Anatasova & Wilson, 2003). Firms' logarithmic sales growth, lagged logarithmic sales growth and ratio of short-term assets to total assets have been statistically tested, but the variables are not significant in any of the models, and have thus been dropped from the final regressions.

As the growth trends of firms' business volume within each year are not known, firms' logarithmic sales growth rate (LSG) is added to the regression models. The proxy is not perfect as a certain growth rate can be measured both for a firm, which has a very steady growth during the year, and thus unbiased trade credit measures, and for a firm with either decreasing or increasing growth trend, and thus biased TCO and TCP ratios. However, the purpose of the variable is primarily to control the possible general downward bias in the trade credit measures in 2008, and for this reason LSG is included in interaction with the crisis year binary variables as a proxy of the growth trend⁴. The underlying assumption is that the turn in the overall economic activity was so severe during 2008 that it is at least partly reflected in the whole year growth figures.

The model for aggregate patterns is as follows:

$$TC_{it} = (u + a_i) + b_1CY_t + b_2LSG_{it} + b_3X_{it} + e_{it}, \quad (3)$$

where TC is one of the three trade credit measures described earlier, u is the estimated intercept, a is the estimated firm fixed effects, CY is a vector of the two crisis year dummy variables, LSG is a vector of logarithmic sales growth during the crisis years, X is a vector of the liquidity variables and size, and e is the estimated idiosyncratic error term.

5.3.3. Cross-Sectional Patterns

To understand what is driving the aggregate patterns, it is necessary to study firms' heterogeneous responses to the crisis. To do this, the use of trade credit is studied relative to the firm's vulnerability to the financial crisis. The most often used proxy for this vulnerability is firm size. Liquidity is also used to test the robustness of the results and to possibly gain understanding of the causal effects, i.e. are the aggregate patterns driven more by the supply or demand side effects and is there evidence supporting the trade credit channel theory⁵.

⁴ Logarithmic sales growth rate has also been tested as an independent control variable, but the estimated coefficients are statistically insignificant (see previous footnote).

⁵ Reliance on short-term debt (measured as short-term bank loans per assets), collateralizable assets (fixed assets per assets), logarithm of firm age and logarithmic age squared (due to previous findings that the relationship may be unlinear) have also been tested as proxies for access to bank credit, but due to their lack of statistical significance, the results are not reported. The effect of stock exchange listing has also been tested by running separate regressions for the sub-samples of quoted and unquoted firms, but the difference between the groups is trivial, and the results are not reported.

The proxies for the vulnerability to the financial crisis (VFC) are included in the model in interaction with the crisis year dummies to analyze their effect in a given year. The model thus becomes:

$$TC_{it} = (u + a_i) + b_1CY_t + b_2VFC_{it} + b_3LSG_{it} + b_4X_{it} + e_{it}, \quad (4)$$

where VFC is one of the three proxies for the financial vulnerability.

First and most often used measure of agency costs, which affects firm's access to bank funding, is firm size, which is measured as the logarithm of total assets (SIZE). Second, several researchers have suggested that what really matters during tight money periods for bank-dependent firms, is the amount of liquidity the firms have. Firms with large cash holdings or an ability to generate cash flows have a cushion to rely on during a financial crisis. Thus they are less vulnerable to the crisis even if they are credit rationed. The argument goes, liquidity-rich firms are also in a better financial position to extend more trade credit to their customers during the crisis and perhaps use trade credit terms as a means of supporting profitable commercial operations. The same liquidity proxies (LIQ1 and LIQ2) that were discussed earlier are used as a second and third measure of the vulnerability to the crisis.

6. Data

Ideally the data would have firm-level observations from firms with a large range in size on a quarterly basis. Unfortunately there is no data set that meets all the criteria. The frequency of data is compromised, and the sample contains annual firm-level data from both large and small firms that is available from the U.K.

The data is obtained from Orbis database. Unlike most of the other databases available, Orbis includes annual accounts also for small and unlisted firms. Following the research tradition, the sample includes only manufacturing firms. Firms are also excluded from the sample, if they are unlikely to have independent financing (i.e. majority owned by other firms), or if their accounting year ends more than +/- 3 months from the calendar year end during the crisis years or 2006.

Data availability also restricts the sample. Only firms, which have data for at least one of the trade credit measures for at least one crisis and one pre-crisis year and total asset data for 2006 are included. Outliers have been treated in two ways. Following Love et al. (2007), all measures of trade credit provided and obtained above one have been eliminated as unreliable⁶. This still does not effectively eliminate outliers from the data, and thus for all variables included in the statistical analyses, outliers falling to the lowest and highest 5% of normal distribution are recoded to the 90% confidence limits of the two-tailed distribution. Consequently 5.58% of observations of trade credit obtained, 6.10% of trade credit provided and 7.61% of net trade credit are recoded. The treatment has a modest effect to the dependent variable means⁷, but notably reduces their standard deviations⁸.

The final sample includes 1,084 firms. The sample is unbalanced, i.e. all the variables are not measured at all the time points in all of the firms. Only approximately 66% of firms have data from all the five years in the research period. The sample is relatively extensive though, as a further 18% of firms have data from all but the first or the last year in the period.

⁶ The first stage outlier elimination removes 3.27% of the observations of TCO and 0.76% of TCP.

⁷ A majority of the extreme values are outside the upper confidence limit, and thus the recoding somewhat decreases the means. For TCO the difference is the largest, 0.88 percentage points. For TCP the difference in averages is 0.54 percentage points and for NTC 0.01 percentage points before and after recoding the outliers.

⁸ The standard deviations decrease from 0.118 to 0.089 in case of TCO, from 0.093 to 0.070 in case of TCP and from 0.082 to 0.066 in case of NTC.

Earlier studies on trade credit use have dealt with mergers and acquisitions (M&A) either by adding up the independent accounts of the merged firms for the years preceding the acquisition or ignoring M&A all together. M&A matter in this study if the trade credit obtained and/or provided ratio differ in the consolidated firms and the acquired company is large enough in relation to the buyer for the difference to reflect in the aggregate ratio. Ignoring M&A is not likely to cause a significant bias. In a data, which includes small firms for which M&A data and the independent accounts of the firms prior to the consolidation are not always available, trying to add up the accounts could cause even a larger bias. Thus M&A are ignored.

6.1. Descriptive Statistics

This chapter describes the sample characteristics. Table 2 shows the descriptive statistics of the continuous variables in the sample after the treatment of outliers. Trade credit payables represent 16.7% of COGS on average and trade receivables are on average 16.3% of sales. The firms are still on average net providers of trade credit, i.e. trade receivables are larger than trade payables in absolute value. However, the variability among firms is large.

Table 2. Descriptive Statistics

Variable	Observation:	Mean	St. Dev.	Minimum	Median	Maximum
Dependent variables:						
Accounts payable / COGS (TCO)	4,228	0.167	0.089	0.000	0.152	0.370
Accounts receivable / Sales (TCP)	4,855	0.163	0.070	0.016	0.164	0.322
Net trade credit / Sales (NTC)	4,207	0.055	0.066	-0.080	0.056	0.191
Independent variables:						
Cash flows /Assets (LIQ1)	4,841	0.069	0.108	-0.267	0.079	0.380
Cash balance / Assets (LIQ2)	4,533	0.110	0.120	0.000	0.063	0.392
Logarithm of total assets (SIZE)	4,882	3.162	1.408	0.472	2.891	6.054
Logarithmic sales growth (LSG)	4,510	0.081	0.208	-0.516	0.067	0.689

The table shows the descriptive statistics for all continuous variables included in the regressions. The total number of firms in the sample is 1,084. The size variable is in millions of pound sterling and other variables are measured as fractions.

Table 3 depicts the breakdown of the sample by firms' asset size at the end of 2006 and industry. As mentioned in relation to sample criteria, all the firms are engaged in manufacturing, but the distribution across manufacturing sectors is extensive. The division of size groups in the table is completely arbitrary and done for illustrative purposes. Approximately 32% of the firms are categorized here as small (having assets less than GBP 10 million). Circa 42% of firms fall into the mid-group of firms having assets between

GBP 10 and 50 million, and these are called medium-size firms hereafter. The group of large firms represents 26% of the sample.

Table 3. Sample Breakdown by Industry and Size

Industry (two-digit Nace Rev. 2 code)	Total	Assets 2006 (MGBP)		
		< 10	10-50	> 50
Manufacture of				
Electronic products and equipment (26, 27)	166	60	59	47
Petroleum, rubber, plastic and other non-metallic mineral products (19, 20, 22, 23)	160	45	69	46
Basic metals and metal products (24, 25)	152	56	63	33
Machinery and equipment (28, 29, 30)	141	40	53	48
Food and beverages (10, 11)	123	31	56	36
Textiles, leather and clothing (13, 14, 15)	85	30	37	18
Wood and paper products (16, 17)	68	15	32	21
Printing and recorded media (18)	44	14	23	7
Chemicals and pharmaceutical products (21)	36	10	13	13
Furnitures (31)	35	13	17	5
Other (12, 32)	74	32	34	8
Total	1,084	346	456	282
Percentage of total		31.92 %	42.07 %	26.01 %
Listed	302	62	85	155
Percentage of asset category	27.86 %	17.92 %	18.64 %	54.96 %
Unlisted	782	284	371	127
Percentage of asset category	72.14 %	82.08 %	81.36 %	45.04 %
Average number of employees in 2006 per asset category	1,808	112	289	6,094
Average age in 2006 per asset category	33	26	32	43

The table presents the division of the firms in the sample by industry and size as well as the frequency of publicly listed companies and the average (mean) age and number of employees at the end of 2006. Due to the low frequency (3) of firms in the group "Manufacture of tobacco products", these firms are reported under other manufacturing.

The distribution of industrial representation within different size groups is remarkably even. Manufacturing electronic products and equipment has the highest frequency of firms within the small firms (17.3%). The largest sector within large firms is the manufacture of machinery and equipment (17.0%), but manufacturing electronic products and equipment is a very close second (16.7%) with the difference being only one firm. Within the medium-size firms manufacturing electronic products and equipment has the third highest frequency (12.9%), while production of non-metallic mineral products has the most extensive representation (15.1%).

Less than 30% of the firms in the sample are listed either in the London Stock Exchange main market or the Alternative Investment Market (AIM). As expected, the frequency of listed firms is highest in the group of large firm, and approximately half (51%) of all the listed firms

in the sample have assets more than GBP 50 million. There is very little difference between the two groups of smaller firms in terms of frequency of public listing.

Asset size is in line with another measure of size, namely the number of employees. The small companies in the sample have on average 112 employees, while the large firms have almost 6,100. The medium-size firms fall in between, but are on average closer to the small firms in this aspect. Table 3 also reports how age is on average related to firm size. The small firms are on average 23 years younger than the large firms.

The rest of this chapter describes the use of trade credit in the sample firms. Figure 2 presents four graphs illustrating trade credit use by year. The first graph on the top left corner shows the average of aggregate trade credit obtained and provided in the whole sample. In light of the trade credit channel theory, the trend lines look quite surprising. The average figures show no evidence that the use of trade credit increases at any point during the crisis. The figure also shows a clear decline in both the trade credit provided and obtained during 2008. In relation to the trade credit provided, these indicative findings seem to support Love et al.'s (2007) results of a decreasing provision of trade credit after the first year of a crisis.

The rest of the graphs in Figure 2 present the use of trade credit by year and firm size. The companies have been divided into the same arbitrary asset size categories as in the earlier review of sample division by industries (Table 3). The two graphs on the right show the provision and obtaining of trade credit separately. The large firms in the sample clearly have more trade payables per COGS on average than firms in the two smaller categories. The finding is similar to an earlier result by Petersen and Rajan (1997), who report accounts payable per COGS are 9% for the small firms in their sample and 19% for the large firms.

The division of trade credit obtained by size categories does not show any evidence of a trade credit channel. The large firms obtain slightly more trade credit on average in 2007 than during the previous three years, but the change is quite modest and followed by a substantial decrease in trade credit obtained in 2008. Based on the theory, large firms should be increasing their trade credit obtained less than smaller firms, but the data shows the average increases in 2007 only in the large firms.

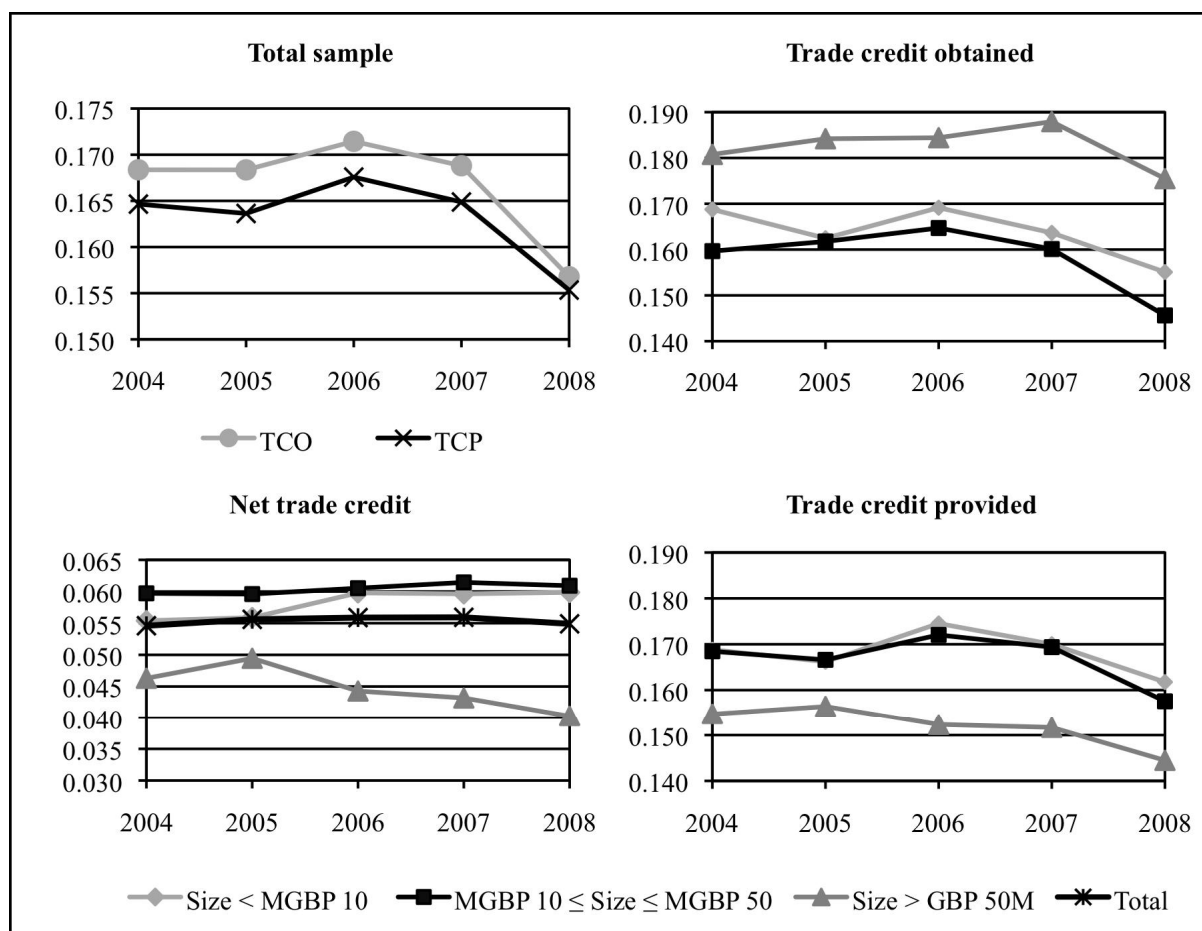


Figure 2. Average Trade Credit by Year

The figure presents the average trade credit measures by year in the sample of 1084 firms. Trade credit provided refers to trade receivables per sales, trade credit obtained to trade payables per cost of goods sold and net trade credit to the difference between trade credit receivables and payables scaled by sales.

The figure indicates opposite results on average trade receivables per sales to what Petersen and Rajan (1997) find. They report small firms do not only borrow less through trade credit, they also extend less trade credit. The recent data from the U.K. in this study shows a conflicting pattern. The group of smallest firms provides the most trade credit on average while the largest firms extend the least trade credit. This may be driven by transaction motives. The informational asymmetries between buyers and sellers are likely to be larger for small sellers, which are also younger on average, and may thus lack track record on product quality and reliability. As suggested by Wilson and Summers (2002) small firms are likely to face conflicting pressure in extending trade credit. They typically have higher cost of raising finance, and thus financing trade credit extension, and they have reduced opportunities to benefit from economies of scale. Their size can, however, put them in an asymmetric bargaining position vis-à-vis their customers so that customer expectation and pressure can drive the decision to grant trade credit and the payment terms offered. This asymmetric relationship is reflected in the results by Howorth and Reber (2003), which show that habitual

late payers are significantly larger than non-habitual late payers. The researchers hypothesize these firms are likely to be larger in relation to their suppliers, and thus able to take advantage of the sellers poor bargaining position.

For both trade credit obtained and provided, the two categories of the smallest firms have very similar trade credit ratios, which also behave very similarly on average during the period under review. The large firms notably differ from the others on average. However, the change in trade credit use during the crisis is similar in all size categories. In 2008 the use of trade credit shows a decrease from the previous year, which is strongly in contradiction with the hypothesis.

Figure 2 also presents firms net trade credit by year in the bottom left corner. In the aggregate, net trade credit is very stable throughout the research period. There is also no evident sign of a change during the crisis in any of the size categories. In 2008 net trade credit seems to have decreased in average in the large firms, but the decrease is not exceptional in light of the changes witnessed during ‘normal times’.

Table 4. Composition of Debt Finance 2006

Type of liabilities	Total	Assets 2006 (MGBP)		
		< 10	10-50	> 50
Short-term liabilities (percentage of total funding)	32.29 %	48.19 %	38.22 %	32.11 %
Bank loans (percentage of short-term liabilities)	9.80 %	21.27 %	23.95 %	9.39 %
Trade credits (percentage of short-term liabilities)	33.56 %	42.65 %	41.26 %	33.32 %
Other (percentage of short-term liabilities)	56.64 %	36.08 %	34.79 %	57.29 %
Long-term liabilities (percentage of total funding)	29.79 %	14.40 %	18.29 %	30.08 %
Bank loans (percentage of long-term liabilities)	39.70 %	63.46 %	66.98 %	39.32 %
Other (percentage of long-term liabilities)	60.30 %	36.54 %	33.02 %	60.68 %

The table presents the composition of debt finance in the 1,030 firms in the sample for which data of long-term liabilities, long-term debt, short-term liabilities, short-term debt and trade payables can be obtained from 2006. The percentages are based on aggregate figures. The short-term and long-term liabilities are calculated as a fraction of equity and liabilities, while the other figures are presented as a fraction of their upper category.

In relation to sales and COGS, large firms in the sample have less trade receivables and more trade payables on average. But in relation to assets and liabilities, small firms use more trade credit. At the end of the financial year 2006, trade receivables represented 30.1% of the total assets of small firms. The corresponding ratio was 22.9% for the medium-size firms and 13.4% for the large firms. Table 4 reports the composition of debt financing at the same point in time. The figures are calculated from the aggregate values, and thus the numbers for the total sample are dominated by the large firms and contain little informative value.

The table shows small firms rely more on short-term funding than large firms. The category of large firms also has notably less bank funding in relation to liabilities than the two other groups. This applies to both short and long-term bank loans. Trade credits represent more than 40% of the short-term financing of the two categories of smallest firms, which in relation to total debt financing translates into 20.6% for the small firms and 15.8% for the medium-size firms. The large firms have trade payables of a relatively low 33.3% of short-term debt and 10.7% of total liabilities. However, trade payables still represent a much larger share of the firms' financing than short-term bank debt.

7. Results

The graphical illustration in the previous chapter implies the use of trade credit behaves very differently in a financial crisis than the trade credit channel theory predicts. It also partly supports Love et al.'s (2007) earlier findings on trade credit during crisis periods. Both ANOVA and regression analyses are employed to analyze the decrease in trade credit statistically. The regression analyses of the cross-sectional patterns in Chapter 7.3 also aim to explain what may cause the decrease in the use of trade credit.

7.1. ANOVA Analysis of Difference in the Aggregate Means

As discussed in the previous chapter, there is some indicative evidence the first hypothesis of firms both extending and receiving more trade credit during a crisis, may not hold. ANOVA analysis for the difference in the means is first used to test the relationship statistically. Table 5 presents the results of the analysis, which support the indicative findings from the graphical description of the use of trade credit on average. Firms both provide and obtain less trade credit during 2008 than during the pre-crisis years. The difference in the means is statistically significant at the 1% level.

Table 5. ANOVA Analysis for Differences in the Means

Trade credit obtained (TCO)	Pre-crisis	2007	2008
	(N=2499)	(N=921)	(N=808)
Mean	0.169	0.169	0.157
Difference in the means F-statistic		(0.040)	(12.645***)
Trade credit provided (TCP)	Pre-crisis	2007	2008
	(N=2868)	(N=1055)	(N=932)
Mean	0.165	0.165	0.155
Difference in the means F-statistic		(0.040)	(14.38***)
Net trade credit (NTC)	Pre-crisis	2007	2008
	(N=2487)	(N=915)	(N=805)
Mean	0.055	0.056	0.055
Difference in the means F-statistic		(0.042)	(0.035)

This table presents the mean trade credit measures during the pre-crisis years 2004-2006 and the crisis years 2007 and 2008. It also reports the one-way ANOVA results of the differences in the means of the given crisis year and the pre-crisis years. TCO is computed as trade credit payables / cost of goods sold, TCP as trade credit receivables / sales and NTC as net trade credit (i.e. trade receivables minus payables) / sales. The sample includes observations from 1,084 firms. F-values are in parenthesis. ***, **, * denote significance at 1 %, 5 % and 10 % level, respectively.

There is no statistically significant difference between the mean trade credit used during the pre-crisis years and the year 2007, thus indicating no empirical evidence to support the preconceived characterization of the year as a crisis year. In terms of corporate financing, or at least trade credit, the year seems not to be different from 'normal times'.

7.2. Regression of Aggregate Patterns

Regression analyses of the aggregate patterns in the use of trade credit show robustness of the results obtained from the ANOVA tests of the difference in the means. Table 6 reports the results of the regressions of Equation 3. The statistically significant Wooldridge test statistics imply there is autocorrelation in the error terms and the significant Wald test statistics point to groupwise heteroskedasticity. The estimated error terms are corrected for clustering to control for the misspecifications in the models.

All the results from the aggregate models of trade credit obtained and provided (models 1-8 in Table 6) clearly support the earlier findings that firms both obtain and provide less trade credit during 2008. The negative coefficient estimators for the binary variable 2008 are statistically significant at the 1% level in all the models. Year 2007 does not pre-eminently differ from the previous control years, although models 7 and 8 show some signs of trade credit provision decreasing during the year. However, the estimated coefficients are small in size and their statistical significance is low.

Models with even numbers include the interaction terms of sales growth and crisis year binary variables as proxies of the change in business volume growth trend during the year. These control variables are expected to have the same sign as the parameter estimates for the corresponding crisis year dummy variables. The variables are included to test that the decrease in trade credit use is not merely a consequence of a negative trend in business volume during the latter half of 2008, which would bias the dependent variables.

The results show sales growth is connected with trade credit provided in 2008. The estimated parameter for 2007 is virtually zero and statistically insignificant, which supports the use of the variable as an appropriate proxy for a change in business volume growth during the year. The inclusion of the control variable decreases the estimated effect of the year 2008, implying a part of the observed aggregate decrease can be explained by the declining sales during the second half of 2008. However, the estimator for 2008 stays statistically significant at the 1% level even after controlling for the change in sales volume. Thus, there is an indication the turn in sales growth trend alone does not explain the decrease in trade credit provided.

Models 3-4, 7-8 and 11-12 include the two control variables for liquidity, cash reserves and cash flow, as well as firm size. Adding the controls does not affect the estimated year variables, which are of interest here. The estimated coefficients of the control variables are

partly surprising. Holding a larger share of assets in cash and other very liquid assets is associated with higher level of trade credit obtained. Calomiris et al. (1994) and Nilsen (2002) argue that firms facing financing constraints or more volatile cash flows hold larger cash balances as a buffer. Their claim is supported by Sufi's findings (2009) that firms with lower cash flows are likely to rely more heavily on cash holdings in their corporate liquidity management. Thus large cash balances may indicate financial vulnerability rather than a strong liquidity position and show an opposite sign than cash flows in the regression results.

Firms, which have stronger cash flows, obtain less trade credit. These firms can be expected to have less need to resort to expensive trade credit, and thus use less trade credit financing. But the results also show a negative relationship between cash flows and trade credit provided in model 7. Explaining this finding is outside of the scope of this study. The result is also no longer statistically significant when the sales growth control variables are added to the equation in model 8. Purely hypothetically, strong cash flows could be correlated with some omitted variable, which is associated with less trade credit provided or the causality may in fact work to the other direction. A quicker trade receivable turnover (i.e. lower trade credit provided ratio) may support firms' cash flows. In net terms stronger cash flows are associated with more trade credit, i.e. cash flows have a larger negative effect to trade credit obtained than trade credit provided.

Firm size seems to be positively related to trade credit obtained and provided, implying larger firms both obtain and provide more trade credit. The coefficients are statistically significant at the 1% level supporting the characterization of the variable as time-variant.

Overall, the aggregate results on net trade credit are weak. As discussed in Chapter 5.3, this is not surprising. Since trade credit obtained and provided change to the same direction during the crisis, the changes may cancel each other out in net terms. Model 9 shows weak evidence of net trade credit decreasing during 2008, i.e. trade credit receivables reducing relatively more than trade credit payables. However, when the control variables are added to the model, the relationship loses statistical significance.

Table 6. Trade Credit in Aggregate

	Exp.	TCO				Exp.	TCP				Exp.	NTC			
	sign	(1)	(2)	(3)	(4)	sign	(5)	(6)	(7)	(8)	sign	(9)	(10)	(11)	(12)
Intercept		0.179*** (174.63)	0.168*** (227.53)	0.086*** (4.52)	0.076*** (3.46)		0.166*** (305.93)	0.165*** (277.68)	0.101*** (6.05)	0.082*** (4.23)		0.056*** (106.75)	0.056*** (99.13)	0.054*** (3.87)	0.048*** (2.70)
2007	+	-0.003 (-1.09)	-0.001 (-0.44)	-0.003 (-1.48)	-0.002 (-1.10)	+	-0.001 (-0.69)	-0.001 (-0.47)	-0.003* (-1.88)	-0.004* (-1.68)	+/-	0.001 (0.72)	0.001 (0.78)	0.001 (0.35)	0.000 (0.08)
2008	+	-0.013*** (-3.91)	-0.011*** (-4.71)	-0.017*** (-7.59)	-0.017*** (-7.01)	+/-	-0.011*** (-6.29)	-0.009*** (-4.33)	-0.014*** (-7.62)	-0.013*** (-6.12)	+/-	-0.003* (-1.67)	-0.002 (-1.10)	-0.002 (-1.00)	-0.001 (-0.68)
2007*Sales growth (LSG)	+/-		0.005 (0.36)		-0.008 (-0.66)	+/-		0.000 (0.02)		-0.011 (-0.92)	+/-		-0.001 (-0.08)		-0.004 (-0.37)
2008*Sales growth (LSG)	+/-		-0.002 (-0.15)		-0.011 (-0.75)	+/-		-0.022** (-2.05)		-0.034*** (-2.69)	+/-		-0.005 (-0.49)		-0.017 (-1.60)
Cash flow (LIQ1)	-			-0.069*** (-4.08)	-0.065*** (-3.58)	+			-0.036*** (-2.85)	-0.022 (-1.64)	+			0.029** (2.22)	0.036*** (2.58)
Cash balance (LIQ2)	-			0.051*** (2.80)	0.048*** (2.61)	+			0.023 (1.24)	0.026 (1.60)	+			-0.014 (-1.18)	-0.006 (-0.48)
Total assets (SIZE)	+			0.026*** (4.39)	0.029*** (4.25)	+/-			0.020*** (3.87)	0.026*** (4.35)	+/-			0.000 (0.07)	0.004 (0.81)
No. of observations		4,228	3,926	3,900	3,729		4,855	4,489	4,479	4,266		4,207	3,910	3,883	3,713
No. of groups		944	926	924	905		1,083	1,061	1,059	1,036		941	923	921	902
F-statistic		20.04***	8.46***	17.70***	11.84***		22.28***	11.29***	16.00***	11.60***		2.96*	1.53	1.84	1.62
Wooldridge test F-statistic		22.137***	16.226***	21.358***	24.111***		12.550***	14.926***	15.872***	16.066***		42.624***	29.341***	34.858***	33.675***
Wald test chi2-statistic		4.4E+07***	3.1E+34***	4.3E+34***	1.1E+37***		1.9E+32***	1.5E+35***	2.6E+34***	4.1E+34***		7.6E+32***	2.2E+35***	3.7E+36***	3.7E+36***

The table shows the results of fixed effects regression analysis. The dependent variables are: TCO is trade payables / cost of goods sold, TCP is trade receivables / sales and NTC is net trade credit (i.e. trade receivables minus payables) / sales. The independent variables are: 2007 and 2008 are the two crisis year dummy variables, LSG is the logarithmic sales growth rate, LIQ1 is cash flows / assets, LIQ2 is cash / assets measured at the beginning of the year and SIZE is the logarithm of firm's assets. The intercept is the average of firm fixed effects. The models are estimated using an unbalanced sample of 1,084 firms and within-effects estimation with cluster robust error terms (see Chapter 5). F-statistic measures the model's goodness of fit. The test statistics refer to Wooldridge test of serial correlation and Wald test of groupwise heteroskedasticity in fixed effect regression. T-statistics are in parentheses. ***, ** and * denote significance at 1 %, 5 % and 10 % level, respectively.

7.3. Cross-Sectional Patterns

To understand what may be driving the aggregate patterns, the rest of the analysis is concentrated on firms' heterogeneous responses to the crisis. The hypotheses 2 and 3 predict that firms, which are more vulnerable to the financial crisis, obtain more and provide less trade credit during a crisis. There are several possible proxies for the vulnerability as discussed in Chapter 5.3.2. This chapter presents the regression results for Equation 4 including measures of firm size and liquidity. Firm size is a proxy for firm's access to bank credit during a crisis, where as liquidity measures mainly firm's dependence on the aforementioned access.

7.3.1. Firm Size

Firm size is the most commonly used proxy for informational frictions, which place firms in a disadvantaged position in bank financing during a credit crunch. Following this uneven position of different-sized firms vis-à-vis banks, the theory expects larger firms to intermediate bank credit to their smaller customers during tight money periods. Based on the trade credit channel theory, there is a hypothesized positive (negative) relationship between size and trade credit provided (obtained) during 2008.

Table 7 reports the results of regressions on Equation 4 with 'Crisis year*SIZE' interaction variables. The decrease in trade credit during 2008 persists and the estimators stay statistically significant at the 1% level in all of the models 1-8 in Table 7. The results also show a positive relationship between size and trade credit obtained and provided. The estimated coefficients are small in size though, and thus the economic significance of the results is somewhat low. In the models including the control variable for size, the results are also statistically weak implying the relationship in 2008 may be partly explained by the higher trade credit use by larger firms in general, not only during the crisis.

The positive size effect is so small⁹ in relation to the overall negative year effect that the results point more to a smaller decrease or no difference in larger firms' use of trade credit during 2008 than to an increase in its use. In 2007, size only seems to be associated with trade credit

⁹ Note that size is measured as a logarithm, and thus with a coefficient of 0.002, would need to be more than GBP 13 billion in absolute value to cancel out the overall year effect with a coefficient of 0.019. The outlier treatment sets the maximum size in the data significantly lower, and thus one should be careful in concluding that firms of any size would actually increase their trade credit provision during the crisis.

obtained. In net terms, size is not associated with trade credit in any of the models 9-12. Thus the results do not offer any evidence to support the hypothesis of a trade credit channel.

The puzzling question is, why is there no trade credit channel. Unfortunately answering the question is beyond the scope of this study and would require a more detailed analysis of large firms. As the data in this study supports the aim to include firms on a wide size range, the number of large firms is not high enough to conduct more detailed statistical tests on the subgroup of large firms.

Love et al. (2007) suggest that supply side effects cause the decrease they find in trade credit provided during financial crises. The results of this study in relation to firm size may be interpreted as supporting the supply-side explanation. As size and trade credit obtained are positively related during both 2007 and 2008, the findings clearly do not point to a decrease in trade credit demand. It seems more likely firms demand more or at least as much trade credit regardless of size, but large firms are (at least to some extent) less vulnerable to the reduction in the provision of trade credit due to e.g. better bargaining power and lower perceived riskiness by suppliers, i.e. the supply does not decrease or decreases less to the large firms, which causes the positive relationship between size and trade credit received.

There are at least two possible reasons why the use of trade credit is found to differ during financial crises than during less severe credit crunches. First, during a crisis credit rationing may affect a larger share of firms. Nilsen (2002) finds that even during contractionary monetary policy, some large firms (e.g. firms without bond rating or lacking collateralizable assets) use trade credit financing very similarly to small firms and suggests they may be credit rationed. In their recent study of financial constraints during the 2008 crisis, Campello et al. (2010) find a very small degree of correlation between firms' size and propensity to declare themselves as either financially constrained or unconstrained. In their survey study, 51% of firms having annual sales of more than USD 1 billion declare themselves as somewhat or very affected by the crisis while the corresponding percentage is 59% for smaller firms. The percentages are high especially as both of their size groups can be considered to represent large firms. Thus their results imply that during a financial crisis, credit rationing may affect many of the firms that are traditionally considered to maintain access to bank credit. Campello et al. (2010) also find most other traditional measures of constraints do not correlate with firms' subjective sense of financial constraints, most notable exception being a credit rating, measured as speculative or investment grade.

Table 7. Trade Credit and Firm Size

	Exp.	TCO				Exp.	TCP				Exp.	NTC			
	sign	(1)	(2)	(3)	(4)	sign	(5)	(6)	(7)	(8)	sign	(9)	(10)	(11)	(12)
Intercept		0.170*** (248.25)	0.168*** (229.94)	0.088*** (4.64)	0.078*** (3.54)		0.166*** (305.44)	0.165*** (275.57)	0.102*** (6.10)	0.083*** (4.30)		0.056*** (106.83)	0.056*** (99.04)	0.053*** (3.79)	0.041*** (2.66)
2007	+	-0.014*** (-3.43)	-0.012*** (-2.77)	-0.013*** (-3.05)	-0.013*** (-2.87)	+	-0.005 (-1.17)	-0.005 (-1.07)	-0.004 (-0.89)	-0.006 (-1.13)	+/-	0.004 (1.24)	0.005 (1.43)	0.004 (1.10)	0.003 (0.92)
2008	+	-0.026*** (-4.94)	-0.025*** (-4.65)	-0.027*** (-4.86)	-0.027*** (-4.87)	+/-	-0.019*** (-4.28)	-0.018*** (-3.73)	-0.018*** (-4.05)	-0.020*** (-4.04)	+/-	0.002 (0.40)	0.003 (0.65)	0.003 (0.97)	0.001 (0.47)
2007*Total assets (SIZE)	-	0.004*** (3.03)	0.003*** (2.70)	0.003** (2.41)	0.003** (2.44)	+	0.001 (1.06)	0.001 (1.06)	0.000 (0.22)	0.001 (0.75)	+	-0.001 (-1.06)	-0.001 (-1.21)	-0.001 (-1.08)	-0.001 (-0.99)
2008*Total assets (SIZE)	-	0.004*** (2.60)	0.004*** (2.66)	0.003* (1.80)	0.003* (1.96)	+	0.002** (2.10)	0.003** (2.23)	0.001 (1.06)	0.002* (1.73)	+	-0.001 (-1.23)	-0.001 (-1.33)	-0.001 (-1.26)	-0.001 (-0.91)
2007*Sales growth (LSG)	+/-		0.004 (0.33)		-0.008 (-0.67)	+/-		0.000 (0.02)		-0.011 (-0.90)	+/-		-0.001 (-0.07)		-0.003 (-0.37)
2008*Sales growth (LSG)	+/-		-0.006 (-0.41)		-0.014 (-0.89)	+/-		-0.024** (-2.22)		-0.035*** (-2.78)	+/-		-0.004 (-0.36)		-0.017 (-1.52)
Cash flow (LIQ1)	-			-0.067*** (-3.94)	-0.062*** (-3.38)	+			-0.035*** (-2.79)	-0.021 (-1.51)	+			0.028** (2.15)	0.035** (2.52)
Cash balance (LIQ2)	-			0.053*** (2.88)	0.049*** (2.71)	+			0.024 (1.50)	0.027* (1.67)	+			-0.015 (-1.24)	-0.007 (-0.52)
Total Assets (SIZE)	+			0.026*** (4.24)	0.028*** (4.15)	+/-			0.020*** (3.81)	0.026*** (4.28)	+/-			0.001 (0.15)	0.004 (0.85)
No. of observations		4,228	3,926	3,900	3,729		4,855	4,489	4,479	4,266		4,207	3,910	3,883	3,713
No. of groups		944	926	924	905		1,083	1,061	1,059	1,036		941	923	921	902
F-statistic		14.29***	7.81***	13.85***	10.19***		11.68***	7.87***	11.50***	9.06***		1.95*	1.37	1.49	1.36
Wooldridge test F-statistic		22.237***	16.333***	21.570***	24.332***		12.848***	15.312***	15.985***	16.211***		42.724***	29.319***	34.901***	33.791***
Wald test chi2-statistic		1.4E+33***	1.1E+34***	4.2E+35***	4.3E+34***		7.2E+33***	5.9E+34***	6.4E+33***	7.2E+34***		1.4E+34***	3.6E+35***	4.9E+34***	3.3E+37***

The table shows the results of fixed effects regression analysis. The dependent variables are: TCO is trade payables / cost of goods sold, TCP is trade receivables / sales and NTC is net trade credit (i.e. trade receivables minus payables) / sales. The independent variables are: 2007 and 2008 are the two crisis year dummy variables, SIZE refers to the logarithm of firm's assets, LSG is the logarithmic sales growth, LIQ1 cash flows / assets and LIQ2 cash / assets measured at the beginning of the year. The intercept is the average of firm fixed effects. The models are estimated using an unbalanced sample of 1,084 firms and within-effects estimation with cluster robust error terms (see Chapter 5). F-statistic measures the model's goodness of fit. The test statistics refer to Wooldridge test of serial correlation and Wald test of groupwise heteroskedasticity in fixed effect regression. T-statistics are in parentheses. ***, ** and * denote significance at 1 %, 5 % and 10 % level, respectively.

The second possibility (which may apply simultaneously with the first one) is that large firms are not necessarily credit rationed, but there is something that distinguishes a crisis from previously studied periods of monetary policy tightening, which makes firms unwilling to provide more trade credit to their customers. One reason could be overall uncertainty of the availability of bank credit in the future. If firms are uncertain whether their bank will be in operation next month or even next week, and the whole financial system looks to be on the verge of collapsing, firms are likely to become cautious about extending trade credit even if they have not been affected by credit rationing so far. Ivashina and Scharfstein (2009) show evidence of such cautious behavior in their study on bank lending during 2008 in the U.S. They find firms increased drawdowns on existing credit lines to ensure they had access to funds at the time of a widespread concern about the solvency of the banking sector. Cambello et al. (2010) find supporting evidence that firms drew funds for the fear that their banks would restrict access to credit in the future.

Unfortunately, these propositions cannot be tested with the data in this study. Both would require more extensive sample of large firms. As the second proposition is based more on firms' future expectations than current financial status, it is likely that finding any plausible evidence for or against it would require data outside financial statements.

7.3.2. Liquidity

Firms with stronger liquidity are less dependent on the availability of bank credit and are therefore expected to obtain less and provide more trade credit during a financial crisis. Liquidity is measured with the same two proxies that are used as control variables in the other models. Here they enter Equation 4 in interaction with the binary year variables.

Table 8 shows the results of the regressions including cash flows per assets (LIQ1) in interaction with the crisis year dummies. Cash flows cannot explain trade credit provided. The interaction terms are not statistically significant in any of the models 4-8 for trade credit provision. In models 1 and 2 the results show trade credit obtained decreasing more in firms with stronger cash flows in 2007 relative to the previous years and in model 2, in which sales growth is controlled, this relationship is statistically significant also in 2008. The reduction in trade credit obtained reflects also to net trade credit in 2008 in model 10, implying that firms with stronger cash flows would increase their net trade credit, i.e. the difference between trade receivables and payables per assets increases with cash flows in 2008.

Table 8. Trade Credit and Cash Flow

	Exp. sign	TCO				Exp. sign	TCP				Exp. sign	NTC			
		(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)		(9)	(10)	(11)	(12)
Intercept		0.170*** (246.04)	0.168*** (226.88)	0.083*** (4.20)	0.072*** (3.19)		0.166*** (300.97)	0.165*** (271.96)	0.103*** (5.95)	0.083*** (4.19)		0.056*** (106.15)	0.056*** (98.76)	0.55*** (3.76)	0.043*** (2.69)
2007	+	0.002 (0.81)	0.005 (1.60)	-0.001 (-0.31)	0.000 (0.10)	+	-0.000 (-0.07)	-0.001 (-0.40)	-0.004 (-1.33)	-0.005 (-1.56)	+/-	-0.001 (-0.25)	-0.000 (-0.01)	0.001 (0.38)	-0.000 (-0.00)
2008	+	-0.009*** (-2.66)	-0.007** (-2.08)	-0.015*** (-4.07)	-0.014** (-3.72)	+/-	-0.011*** (-4.74)	-0.009*** (-3.63)	-0.015*** (-5.83)	-0.013*** (-4.59)	+/-	-0.004** (-1.99)	-0.004* (-1.75)	-0.002 (-0.91)	-0.002 (-0.82)
2007*Cash flow (LIQ1)	-	-0.049** (-2.08)	-0.068*** (-2.58)	-0.025 (-0.95)	-0.035 (-1.27)	+	-0.014 (-0.59)	0.007 (0.32)	0.016 (0.57)	0.025 (0.95)	+	0.004 (0.23)	0.015 (0.82)	-0.005 (-0.23)	0.002 (0.10)
2008*Cash flow (LIQ1)	-	-0.052 (-1.58)	-0.064** (-2.00)	-0.033 (-0.90)	-0.044 (-1.18)	+	0.000 (0.01)	0.010 (0.43)	0.018 (0.72)	0.011 (0.41)	+	0.027 (1.42)	0.040** (1.96)	0.007 (0.30)	0.013 (0.54)
2007*Sales growth (LSG)	+/-		0.009 (0.65)		-0.008 (-0.62)	+/-		-0.000 (-0.02)		-0.011 (-0.91)	+/-		-0.001 (-0.14)		-0.003 (-0.34)
2008*Sales growth (LSG)	+/-		0.004 (0.33)		-0.01 (-0.69)	+/-		-0.023** (-2.02)		-0.034*** (-2.67)	+/-		-0.011 (-1.17)		-0.018* (-1.65)
Cash flow (LIQ1)	-			-0.057*** (-2.88)	-0.49** (2.29)	+			-0.043*** (-2.58)	-0.030* (-1.65)	+			0.028* (1.78)	0.033* (1.94)
Cash balance (LIQ2)	-			0.051*** (2.81)	0.048*** (2.66)	+			0.022 (1.43)	0.026 (1.57)	+			-0.014 (-1.19)	-0.006 (-0.50)
Total Assets (SIZE)	+			0.027*** (4.39)	0.030*** (4.32)	+/-			0.020*** (3.70)	0.026*** (4.22)	+/-			0.000 (0.04)	0.004 (0.74)
No. of observations		4,196	3,897	3,900	3,729		4,814	4,453	4,479	4,266		4,175	3,881	3,883	3,713
No. of groups		940	922	924	905		1,079	1,057	1,059	1,036		937	919	921	902
F-statistic		15.21***	9.25***	13.89***	10.27***		12.17***	8.19***	11.69***	9.43***		1.73	1.70	1.35	1.34
Wooldridge test F-statistic		22.576***	15.884***	21.406***	23.828***		12.164***	14.796***	16.371***	16.663***		43.464***	29.712***	35.597***	34.300***
Wald test chi2-statistic		2.1E+33***	1.9E+34***	1.2E+35***	7.2E+33***		2.8E+33***	2.5E+35***	1.3E+34***	5.4E+34***		1.0E+36***	1.0E+36***	1.8E+36***	1.1E+37***

The table shows the results the fixed effects regression analysis. The dependent variables are: TCO is trade payables / cost of goods sold, TCP is trade receivables / sales and NTC is net trade credit (i.e. trade receivables minus payables) / sales. The independent variables are: 2007 and 2008 are the two crisis year dummy variables, LIQ1 refers to cash flows / assets, LSG is the logarithmic sales growth, LIQ2 is cash / assets measured at the beginning of the year and SIZE is the logarithm of firm's assets. The intercept is the average of firm fixed effects. The models are estimated using an unbalanced sample of 1,084 firms and within-effects estimation with cluster robust error terms (see Chapter 5). F-statistic measures the model's goodness of fit. The test statistics refer to Wooldridge test of serial correlation and Wald test of groupwise heteroskedasticity in fixed effect regression. T-statistics are in parentheses. ***, ** and * denote significance at 1 %, 5 % and 10 % level, respectively.

But when the level of cash flows is controlled in models 3, 4, 11 and 12, the results lose their statistical significance. It seems the overall negative relationship between cash flows and trade credit obtained explains the findings in models 1 and 2, and not their special relationship during a crisis. The same applies to net trade credit, to which cash flows have a general positive effect. Thus the results on cash flows do not support the hypothesis of a particular relationship of liquidity and trade credit use during a crisis.

Using cash balances to measure liquidity leads to a similar conclusion. Table 9 shows the regression results when cash balance (LIQ2) is included in the model in interaction with the crisis year variables. Larger cash balances are associated with higher levels of trade credit obtained during 2008 in models 1 and 2. But the result does not hold, when the control variable for the level of cash holdings is included in the model.

The results show net trade credit increasing with cash balances during 2007. The result is stable, although its statistical significance is weak. Firms with large cash balances seem to increase trade credit provision more (or decrease it less) than the trade credit they obtain themselves in 2007, but in 2008 this no longer applies. In general cash balance has no or a negative relationship with trade credit, and thus the finding for 2007 is somewhat puzzling.

Table 9. Trade Credit and Cash Balance

	Exp. sign	(1) TCO	(4) TCO	(7) TCO	(10) TCO	Exp. sign	(2) TCP	(5) TCP	(8) TCP	(11) TCP	Exp. sign	(3) NTC	(6) NTC	(9) NTC	(12) NTC
Intercept		0.169*** (232.81)	0.169*** (222.30)	0.087*** (4.53)	0.078*** (3.50)		0.165*** (82.49)	0.165*** (272.63)	0.102*** (6.10)	0.082*** (4.27)		0.056*** (101.56)	0.056 (96.95)	0.056*** (3.99)	0.043*** (2.79)
2007	+	-0.001 (-0.49)	-0.002 (-0.65)	-0.002 (-0.86)	-0.002 (-0.81)	+	-0.002 (-0.85)	-0.001 (-0.72)	-0.003 (-1.61)	-0.003 (-1.26)	+/-	-0.001 (-1.10)	-0.002 (-0.82)	-0.002 (-1.20)	-0.003 (-1.17)
2008	+	-0.016*** (-5.58)	-0.016*** (-5.18)	-0.020*** (-6.64)	-0.020*** (-6.11)	+/-	-0.012*** (-5.43)	-0.011*** (-4.20)	-0.015*** (-6.23)	-0.014*** (-5.18)	+/-	-0.002 (-1.10)	-0.002 (-0.67)	-0.003 (-1.23)	-0.002 (-0.73)
2007*Cash Balance (LIQ2)	-	0.013 (0.93)	0.017 (1.16)	-0.006 (-0.39)	-0.001 (-0.09)	+	0.009 (0.51)	0.005 (0.32)	0.003 (0.15)	-0.004 (-0.22)	+	0.021 (1.47)	0.022* (1.65)	0.028* (1.88)	0.028* (1.91)
2008*Cash Balance (LIQ2)	-	0.040** (1.99)	0.043** (2.12)	0.022 (1.03)	0.027 (1.21)	+	0.015 (0.77)	0.019 (0.90)	0.008 (0.37)	0.009 (0.39)	+	0.003 (0.20)	0.001 (0.06)	0.01 (0.59)	0.004 (0.24)
2007*Sales growth (LSG)	+/-		0.002 (0.16)		-0.008 (-0.65)	+/-		-0.000 (-0.01)		-0.011 (-0.89)	+/-		-0.000 (-0.02)		-0.004 (-0.45)
2008*Sales growth (LSG)	+/-		0.002 (0.11)		-0.011 (-0.73)	+/-		-0.023 (-1.99)		-0.034*** (-2.71)	+/-		-0.011 (-1.13)		-0.017 (-1.60)
Cash flow (LIQ1)	-			-0.070*** (-4.12)	-0.066*** (-3.62)	+			-0.036*** (-2.87)	-0.023* (-1.67)	+			0.029** (2.22)	0.036*** (2.58)
Cash balance (LIQ2)	-			0.047** (2.34)	0.042** (2.05)	+			0.021 (1.23)	0.025 (1.41)	+			-0.022* (-1.66)	-0.012 (-0.92)
Total Assets (SIZE)	+			0.026*** (4.38)	0.029*** (4.23)	+/-			0.020*** (3.87)	0.026*** (4.37)	+/-			0.000 (0.01)	0.004 (0.76)
No. of observations		3,925	3,753	3,900	3,729		4,510	4,296	4,479	4,266		3,908	3,737	3,883	3,713
No. of groups		927	908	924	905		1,062	1,039	1,059	1,036		924	905	921	902
F-statistic		12.74***	8.11***	14.39***	10.51***		12.44***	9.16***	12.60***	10.19***		1.20	1.13	1.67	1.64
Wooldridge test F-statistic		16.156***	14.631***	21.373***	24.096***		13.004***	15.746***	16.269***	16.563***		34.116***	32.491***	36.024***	34.489***
Wald test chi2-statistic		6.3E+33***	8.5E+34***	4.3E+34***	2.1E+34***		1.8E+35***	9.1E+33***	8.6E+34***	1.9E+37***		2.9E+35***	1.5E+35***	8.7E+34***	2.6E+35***

The table shows the results of fixed effects regression analysis. The dependent variables are: TCO is trade payables / cost of goods sold, TCP is trade receivables / sales and NTC is net trade credit (i.e. trade receivables minus payables) / sales. The independent variables are: 2007 and 2008 are the two crisis year dummy variables, LIQ2 refers to cash / assets measured at the beginning of the year, LSG is the logarithmic sales growth, LIQ1 is cash flows / assets and SIZE is the logarithm of firm's assets. The intercept is the average of firm fixed effects. The models are estimated using an unbalanced sample of 1,084 firms and within-effects estimation with cluster robust error terms (see Chapter 5). F-statistic measures the model's goodness of fit. The test statistics refer to Wooldridge test of serial correlation and Wald test of groupwise heteroskedasticity in fixed effect regression. T-statistics are in parentheses. ***, ** and * denote significance at 1 %, 5 % and 10 % level, respectively.

8. Conclusions

In this thesis I have studied the trade credit firms obtain from their suppliers and provide to their customers during the recent financial crisis of 2007-2008 using a panel data consisting of 1,084 small and large firms in the U.K. The hypothesis was to find an increase in the use of trade credit in line with the proposition of the trade credit channel theory (Hypothesis 1). The theory is widely tested during periods of contractionary monetary policy, but following the results by Love et al. (2007), who also study trade credit use during financial crises, there was predetermined uncertainty whether trade credit provided would actually fall after the early stages of the crisis. This study also attempted to explain, what may cause the potential change in the use of trade credit, the hypothesis being that firms, which are more vulnerable to the financial crisis obtain more and provide less trade credit than less vulnerable firms (Hypothesis 1 and 2).

Table 10. Hypotheses and Results

Independent variable	Dependent variable			
	Trade credit obtained		Trade credit provided	
	Hypothesis	Result	Hypothesis	Result
Year 2007	+	n/a	+	(-)
Year 2008	+	-	+/-	-
Firm size	-	+	+	(+)
Liquidity	-	n/a	+	n/a

The table summarizes the hypothesized and found relationships between dependent and independent variables. Brackets around the sign signify certain uncertainty in the result due to unrobustness in the statistical significance, n/a refer to no result.

This study has attempted to answer two questions. First, does the use of trade credit change when bank lending is limited? The results show robust evidence for an affirmative answer. As Table 10 summarizes, this study finds a decrease in both trade credit provided and supplied during 2008. The results are statistically significant in all of the regression models as well as in the ANOVA analysis of the difference in the aggregate means. The finding is in strong violation with Hypothesis 1, but in regard to the decreasing provision of trade credit after the early stages of a crisis, the result is similar to what Love et al. (1997) find when they study trade credit use during financial crises in the 1990's. This study thus offers further evidence that the use of trade credit behaves differently during financial crises than contractionary monetary policy. Although there is some evidence of trade credit use decreasing already in 2007, the results mainly do not support the characterization of the 2007 as a crisis year for the purpose of this study.

The second question was, does firms' vulnerability to the crisis affect the change in the use of trade credit? In terms of explaining why trade credit use decreases in 2008, this study is able to provide only little insights. The regression results show some evidence of larger firms providing more trade credit during 2008, but size is also positively associated with trade credit obtained. This seems to suggest it is more likely the aggregate results are driven by the supply of rather than demand for trade credit, but explaining the results would require a more detailed analysis of large firms, which is outside of the scope of this study.

Liquidity is unable to explain the reduction in the use of trade credit during 2008. Stronger liquidity is in general associated with less use of obtained trade credit, but there is no evidence of a special relationship during a crisis. Results on liquidity and trade credit provision are overall somewhat mixed and unrobust, and there is no sign of liquidity affecting firms' provision of trade credit during the crisis.

This study shows robust evidence that there was no trade credit channel during the crisis in the U.K. Further studies are needed to explain the aggregate decrease in the use of trade credit. From a theoretical and logical standpoint it is hard to argue, why the decrease would be demand-driven, and studies could focus on what causes the supply to dry up in a crisis unlike during monetary policy contractions. An interesting aspect for future studies would also be to extend the time period further to analyze how long does it take for trade credit to recover from the crisis.

The ability to explain the use of trade credit with financial statement data is limited. Trade credit receivables or payables do not reveal direct information about supply of or demand for trade credit. During a financial crisis, when actions are driven to a greater extent by future uncertainty, the problem of relying on firms' current financial standing is emphasized. Further studies should broaden the research to studies on proprietary data, which at its best would link buyers and sellers directly.

Appendices

List of Variables

Abbreviation	Name	Description
Dependent variables (TC)		
TCO	Trade credit obtained	Trade credit payables scaled by cost of goods sold.
TCP	Trade credit provided	Trade credit receivables scaled by sales.
NTC	Net trade credit	The difference between trade credit receivables and payables scaled by sales. A positive (negative) figure imply the firm provides more (less) trade credit than it obtains itself relative to sales.
Independent variables		
Crisis year dummies (CY)		
2007	First crisis year	A dummy variable for the year 2007, i.e. the first crisis year in the research period. The variable gets a value 1 if the observation is from year 2007 and 0 otherwise.
2008	Second crisis year	A dummy variable for the year 2007, i.e. the second crisis year in the research period. The variable gets a value 1 if the observation is from year 2008 and 0 otherwise.
Measures of the vulnerability to the financial crisis (VFC)		
SIZE	Firm size	Logarithm of firm's total assets.
LIQ1	Cash flows	Cash flows scaled by assets. Cash flows are included as a proxy for liquidity. Cash flows are estimated as the sum of net income and depreciation.
LIQ2	Cash balances	Cash and cash equivalents scaled by assets at the beginning of the year. Cash balances are included as a proxy for liquidity.
Control variables (LSG)		
LSG	Sales growth	The logarithm of annual sales growth rate. The variable is included as a proxy for business volume growth trend change during a year and is targeted to control the market level decrease in volume during the latter half of 2008.
Control variables (X)		
LIQ1	Cash flows	See description above.
LIQ2	Cash balances	See description above.
SIZE	Firm size	See description above.

Sources

Arellano, M., 1993, On the testing of correlated effects with panel data, *Journal of Econometrics* 59:1-2, 87-97.

Atanasova, C.V., Wilson, N., 2003, Bank Borrowing Constraints and the Demand for Trade Credit: Evidence from Panel Data, *Managerial and Decision Economics* 24/6-7, 503-514.

Atanasova, C., 2007, Access to Institutional Finance and the Use of Trade Credit, *Financial Management* 36:1, 49-67.

Atradius, 2009a, *Atradius Payment Practices Barometer: Survey of Payment Behaviour of European Companies. Results Winter 2008/2009*, May 2009. Available online at http://global.atradius.com/images/stories/Publications/payment_practices/20090513_AtradiusPB_EN_Final.pdf.

Atradius, 2009b, *The global economic crisis: Assessing the impact of the crisis on businesses across four continents. Results August 2009*, November 2009. Available online at http://global.atradius.com/images/stories/Publications/Atradius_ecs_no%20countries_new.pdf

Bank of England, 2007, *Agents' Summary of Business Conditions. December 2008*. Available online at <http://www.bankofengland.co.uk/publications/agentssummary/agsum07dec.pdf>.

Bank of England, 2008a, *Agents' Summary of Business Conditions. October 2008*. Available online at <http://www.bankofengland.co.uk/publications/agentssummary/agsum08oct.pdf>.

Bank of England, 2008b, *Agents' Summary of Business Conditions. December 2008*. Available online at <http://www.bankofengland.co.uk/publications/agentssummary/agsum08dec.pdf>.

Bank of England, 2009a, *Inflation Report. February 2009*. Available online at <http://www.bankofengland.co.uk/publications/inflationreport/ir09feb.pdf>.

Bank of England, 2009b, *Trend in Lending. April 2009*. Available online at <http://www.bankofengland.co.uk/publications/other/monetary/TrendsApril09.pdf>.

Baum, C. F., 2001, Residual diagnostics for cross-sectional time series regression models, *The Stata Journal* 1:1, 101-104.

- Bernanke, B., Gertler, M., Gilchrist, S., 1996, The Financial Accelerator and the Flight to Quality, *The Review of Economics and Statistics* 78:1, 1-15.
- Biais, B., Gollier, C., 1997, Trade Credit and Credit Rationing, *The Review of Financial Studies* 10:4, 903-937.
- Brennan, M. J., Maksimovic, V., Zechner, J., 1988, Vendor Financing, *The Journal of Finance* 43:5, 1127-1141.
- Burkart, M., Ellingsen, T., 2004, In-Kind Finance: A Theory of Trade Credit, *The American Economic Review* June 2004, 569-590.
- Calomiris, C. W., Himmelberg, C. P., Wachtel, P., 1994, Commercial Paper, Corporate Finance, and the Business Cycle: A Microeconomic Perspective, *National Bureau of Business Research Working Paper* No. 4848.
- Campello, M., Graham, J. R., Harvey, C. R., 2010, The real effects of financial constraints: Evidence from a financial crisis, *Journal of Financial Economics* 97:3, 470-487.
- Cuñat, v., 2007, Trade Credit: Suppliers as Debt Collectors and Insurance providers, *Review of Financial Studies* 20:2, 491-527.
- De Blasio, G., 2005, Does Trade Credit Substitute Bank Credit? Evidence from Firm-level Data, *Economic Notes by Banca Monte de Paschi di Siena* 34:1, 85-112.
- Demirgüç-Kunt, A., Maksimovic, V., 2001, Firms as Financial Intermediaries: Evidence from Trade Credit Data, *World Bank Policy Research Working Paper* No. 2696.
- Drukker, F. M., 2003, Testing for serial correlation in linear panel-data models, *The Stata Journal* 3:2, 168-177.
- Elliehausen, G. E., Wolken, J. D., 1993, The Demand for Trade Credit: An Investigation of Motives for Trade Credit Use by Small Businesses, *Paper 165*, Board of Governors of the Federal Reserve System.
- Emery, G. W., 1984, A Pure Financial Explanation for Trade Credit, *Journal of Financial and Quantitative Analysis* 19, 271-285.

- Fabbri, D., Menichini, N. M. C., 2010, Trade credit, collateral liquidation, and borrowing constraints, *Journal of Financial Economics* 96, 413-432.
- Ferris, J. S., 1981, A Transaction Theory of Trade Credit Use, *Quarterly Journal of Economics* 94, 243-270.
- Fisman, R., Love, I., 2003, Trade Credit, Financial Intermediary Development, and Industry Growth, *The Journal of Finance* 58, 353-374.
- Frank, M. Z., Maksimovic, V., 2005, Trade Credit, Collateral, and Adverse Selection, *UBC Working Paper*.
- Ge, Y., Qiu, J., 2007, Financial Development, Bank Discrimination and Trade Credit, *Journal of Banking and Finance* 31, 513-530.
- Gertler, M., Gilchrist, S., 1993, The Role of Credit Market Imperfections in the Monetary Transmission Mechanism: Arguments and Evidence, *Scandinavian Journal of Economics* 95:1, 43-64.
- Gertler, M. & Gilchrist, S., 1994, Monetary Policy, Business Cycles, and the Behavior of Small manufacturing Firms, *The Quarterly Journal of Economics* 109:2, 309-340.
- Hausman, J. A., 1978, Specification tests in econometrics, *Econometrica* 46, 1251-1271.
- Howorth, C., Reber, B., 2003, Habitual Late Payment of Trade Credit: An Empirical Examination of UK Small Firms, *Managerial and Decision Economics* 24, 471-482.
- Huyghebaert, N., Van de Gucht, L. M., Van Hulle, C., 2001, The Demand for Debt Finance by Entrepreneurial Firms, *EFA 2001 Barcelona Meetings; K.U. Leuven Department of Applied Economics Working Paper No. 0110*.
- Huyghebaert, N., 2006, On the Determinants and Dynamics of Trade Credit Use: Empirical Evidence from Business Start-ups, *Journal of Business & Accounting* 33:1-2, 305-328.
- IMF, 2009, United Kingdom: 2009 Article IV Consultation—Staff Report, *IMF Country Report No. 09/212*.
- Ivashina, V., Scharfstein, D., 2010, Bank lending during the financial crisis of 2008, *Journal of Financial Economics* 97:3, 319-338.

- Jain, N., 2001, Monitoring costs and trade credit, *The Quarterly Review of Economics and Finance* 41, 89-110.
- Kohler, M., Britton, E., Yates, T., 2000. Trade Credit and the Monetary Transmission Mechanism, *Bank of England Working Paper*.
- Love, I., Preve, L. A., Sarria-Allende, V., 2007, Trade Credit and Bank Credit: Evidence from Recent Financial Crises, *Journal of Financial Economics* 83, 453-469.
- Long, M. S., Malitz, I. B., Ravid, S. A., 1993, Trade Credit, Quality Guarantees, and Product Marketability, *Financial Management* 22, 117-127.
- Longhofer, S. D., Santos, J. A. C., 2003, The Paradox of Priority, *Financial Management* Spring 2003, 69-81.
- Mateut, S., Bougheas, S., Mizen, P., 2006, Trade Credit, Bank Lending and Monetary Policy Transmission, *European Economic Review* 50, 603-629.
- Meltzer, A. H., 1960, Mercantile Credit, Monetary Policy, and Size of Firms, *The Review of Economics and Statistics* 42:4, 429-437.
- Mian, S. L., Smith, C. W., 1992, Accounts Receivable Management Policy: Theory and Evidence, *The Journal of Finance* 47:1, 169-200.
- Myers, S.C., Majluf, N. S., 1984, Corporate Financing and Investment Decisions When Firms Have Information Investors Do Not Have, *Journal of Financial Economics* 13, 187-222.
- Ng, C. K., Smith, J. Kiholm, Smith R. L., 1999, Evidence on the Determinants of Credit Terms Used in Interfirm Trade, *The Journal of Finance* 52:3, 1109-1129.
- Nilsen, J. H., 2002, Trade Credit and the Bank Lending Channel, *Journal of Money, Credit and Banking* 34:1, 226-253.
- Oliner, S. D., Rudebusch, G. D., 1996, Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance: Comment, *American Economic Review* 86:1, 300-309.
- Petersen, M. A., Rajan, R. G., 1997, Trade Credit: Theories and Evidence, *The Review of Financial Studies* 10:3, 661-691.

- Pike, R., Cheng, N. S. 2001, Credit Management: An Examination of Policy Choices, Practices and Late Payment in UK Companies, *Journal of Business Finance & Accounting* 28:7-8, 1013-1042.
- Plümper, T., Troeger, V. E., 2007, Efficient Estimation of Time-Invariant and rarely Changing Variables in Finite Sample Panel Analyses with Unit Fixed Effects, *Political Analysis* 15:2, 124-139.
- Ramey, 1992, The Source of Fluctuations in Money, *Journal of Monetary Economics* 30, 171-193.
- Taketa, K., Udell, G. F., 2007, Lending Channels and Financial Shocks: The Case of Small and Medium-Sized Enterprise Trade Credit and the Japanese Banking Crisis, *Monetary and Economic Studies* 25:2, 1-44.
- Smith, J. Kiholm, 1987, Trade Credit and Informational Asymmetry, *The Journal of Finance* 42:4, 863-872.
- Sufi, A., 2009, Bank Lines of Credit in Corporate Finance: An Empirical Analysis, *The Review of Financial Studies* 22:3, 1057-1088.
- Summers, B., Wilson, N., 2000, Trade Credit Management and the Decision to Use Factoring: An Empirical Study, *Journal of Business & Accounting* 27:1-2, 37-68.
- Tsuruta, D., 2007, Credit Contagion and Trade Credit Supply: Evidence from Small Business Data in Japan, *RIETI Discussion Paper Series* 07-E-043.
- Williams, R. L., 2000, A Note on Robust Variance Estimation for Cluster-Correlated Data, *Biometrics* 56, 645-646.
- Wilner, B. S., 2000, The Explanation of Relationships in Financial Distress: The Case of Trade Credit, *The Journal of Finance* 55:1, 153-178.
- Wilson, N., Summers, B., 2002, Trade Credit Terms Offered by Small Firms: Survey Evidence and Empirical Analysis, *Journal of Business & Accounting* 29:3-4, 317-351.
- Wooldridge, J. M., 2003, Cluster-Sample Methods in Applied Econometrics, *American Economic Review* 93, 133-138.