

Firms as liquidity providers: Evidence from the 2007-2008 financial crisis

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Abstract

Using a supplier-client matched sample, we study the effect of the 2007-2008 financial crisis on between-firm liquidity provision. Consistent with a causal effect of a negative shock to bank credit, we find that firms with high pre-crisis liquidity levels increased the trade credit extended to other corporations and subsequently experienced better performance as compared to ex-ante cash-poor firms. Trade credit taken by constrained firms increased during this period. These findings are consistent with firms providing liquidity insurance to their clients when bank credit is scarce and provide an important precautionary savings motive for accumulating cash reserves.

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1. Introduction

In this paper we analyze how shocks to the banking sector and more broadly to financial markets affect the intra-firm provision of trade credit, a substitute form of credit. The hypotheses we take to the data are based on trade credit theories according to which constrained clients increase the demand for trade credit when there is rationing in the bank markets (Biais and Gollier, 1997; Burkart and Ellinsen, 2004), and suppliers provide liquidity to customers experiencing a temporary liquidity shock (Wilner, 2000; Cuñat, 2007). Accordingly, when liquidity in the financial markets is scarce, cash-rich suppliers face lower opportunity cost of funds and hence are in a better position to provide liquidity insurance through an increased amount of trade credit provided to their constrained clients.

The supply-driven nature of the 2007-2008 financial crisis provides a unique opportunity to study the role of alternative sources of financing in compensating for unavailable credit from banks and financial markets.¹ Contrary to other financial disruptions that have their roots in the real sector, the 2007-2008 crisis is largely attributed to a reversal in the real estate market together with a perceived lack of transparency of the investment portfolios of financial institutions, leading to severe balance sheet problems in the financial sector, and consequently to a lending contraction.²

¹ Evidence of a supply shock to credit markets abounds. Ivashina and Scharfstein (2010) show that new bank loans to large borrowers fell by 79% from Q2:2007 to Q4:2008. Similarly, the responses to the Federal Reserve's Senior Loan Officer Opinion Survey on Bank Lending Practices indicate that banks significantly tightened credit standards on Commercial and Industrial loans in ten consecutive quarters (2007:Q3 to 2009:Q4). In addition, credit spreads widened to unprecedented levels at the onset of the crisis and remained quite elevated for an extended period of time. For example, Almeida et al. (2012) report a dramatic increase in spreads on long-term corporate bonds starting in August 2007, both for investment-grade and junk-rated high yield bonds. Similarly, the spread over the fed funds rate on commercial paper increased significantly during the recession according to data from the Federal Reserve. The drop in bank lending and the rise in spreads are indications of the credit supply shock and the tighter credit conditions faced by non-financial firms.

² See, for example, Gorton (2009) and Acharya et al. (2009) for discussions on the causes of the crisis.

The effects of this lending contraction on demand for credit were contained prior to the bankruptcy of Lehman Brothers in September 2008 (Almeida et al., 2012; Duchin, Ozbas, and Sensoy, 2010) and therefore we shall focus our empirical analysis on the first stage of the financial crisis (roughly from July 2007 to June 2008), where the supply effects dominate. This situation allows us to test whether an exogenous and unexpected shock to the supply of bank credit causes an increase in the amount of trade credit extended by firms, as a function of their access to liquidity. By the same token, the use of trade credit should increase more for credit constrained firms.

We explore these ideas using a matched sample of suppliers and customers of U.S public firms, which allows us to test our hypothesis while controlling for both supply and demand factors. To further address endogeneity concerns, we use a differences-in-differences approach in which we compare trade credit before and after the beginning of the crisis as a function of firms' financial positions measured one year prior to the onset of the crisis. In some of the analyses, we also exploit the fact that the matched sample includes the same firm as client to several suppliers, which allows controlling for time-varying client unobserved heterogeneity. This is a key advantage of this sample as it further controls for demand effects. Jimenez et al (2012) follow a similar approach.

Our estimates suggest that firms with high liquidity holdings before the crisis increased the amount of trade credit offered to their clients during the crisis by 9.8 to up to 22 million dollars, an amount that is equivalent to up to a fourth of the yearly limit in lines of credit for an average firm. The main beneficiaries of these liquidity transfers were constrained firms having commercial relationships with relatively liquid suppliers, which significantly increased the use of trade credit during the crisis.

The increase in accounts receivable by the most liquid firms is consistent with a supply-side effect in which suppliers that are able use their extra liquidity to support their clients during the credit crunch. Similarly, our analysis of accounts payable is consistent with a demand effect in which credit flowed from liquid suppliers to their most constrained clients. These findings provide support for the aforementioned theories proposing suppliers as liquidity providers (Cuñat, 2007; Wilner, 2000), as well as for theories claiming that trade credit is a substitute for bank credit (Biais and Gollier, 1997; Burkart and Ellingsen, 2004). Empirically, Petersen and Rajan (1997), Boissay and Gropp (2007), and Burkart, Ellingsen, and Giannetti (2011) have found evidence consistent with these theories. Our findings complement theirs with three important contributions. First, we deal with endogeneity by exploiting an unexpected negative credit supply shock and measuring liquidity stocks well before the start of the crisis. Second, we control simultaneously for demand and supply of credit using a supplier-customer matched sample. Third, we analyze a period of aggregate liquidity shortage instead of idiosyncratic liquidity shocks. In this latter sense, our paper is related to Love, Preve and Sarria-Allende (2007) who focus on the impact of financial crises on trade credit flows using firm-level data from several currency crises in emerging economies.

To further reduce endogeneity concerns we perform several complementary analyses. First, we follow Rajan and Zingales (1998) and construct industry-level measures of dependence on external finance. Results imply that only firms in industries with low dependence on external finance are able to provide additional liquidity to their clients, especially if the clients have high dependence in external finance. This finding suggests that firms that rely strongly on the affected financial sector for liquidity are

unable to pass on their scarce liquidity to their clients, and supports our interpretation of a causal effect of the supply shock. In a second related analysis, we explore whether firms used their pre-committed lines of credit to increase the trade credit provided to their clients. Our results suggest that firms with better access to bank credit through pre-existing commitments are using their lines of credit to increase the amount of trade credit provided to their clients, especially when clients do not have enough internal and externally provided liquidity. Finally, we examine clients' use of trade credit as a function of their suppliers' liquidity, and find that the use of trade credit increased the most for clients with more liquid suppliers. These findings support the redistribution theory of trade credit, which posits that firms with better access to capital will redistribute the credit they receive to less advantaged firms via trade credit (Meltzer, 1960; Calomiris, Himmelberg, and Wachtel, 1995; Petersen and Rajan, 1997; Nilsen, 2002).

In the remainder of the paper we explore how the events unfold as the crisis intensified following the collapse of Lehman brothers (when the supply for credit further deteriorated, but there was also a huge decline in demand), as well as during the post-crisis period. To this end, we extend the sample up to the second quarter of 2010, a year after the official end of the recession. We find that ex-ante liquid suppliers who helped their clients during 2007-2008 suffered a depletion of their cash reserves. As the crisis became more severe and demand collapsed, these ex-ante liquid suppliers reduced their amount of trade credit offered to their clients and began to replenish their cash stocks. This finding highlights the limitations of trade credit to absorb shocks in an extreme scenario of scarce institutional credit and market illiquidity (Love et al., 2007). We also find that cash-rich firms which increased liquidity provision during the crisis exhibit

better performance during and after the crisis. The subsequent superior performance of liquid suppliers that increased the provision of trade credit during the financial phase of the crisis further supports our main hypothesis that commercial relationships are valuable, implying that suppliers willingly provided liquidity to their clients.

Our results also contribute to the large and growing literature on the causes and effects of the 2007-2008 financial crises (see for example Gorton, 2009; Acharya et al., 2009; Brunnermeier, 2009). Our paper fits within a smaller set of papers which study the effects of the crisis on financial policies of non-financial corporations. The general result of this literature is that the credit supply shock has an economically significant impact on corporations. Tong and Wei (2008), for example, find that stock price declines were steeper for firms that were more constrained. Similarly, Campello, Graham, and Harvey (2010) and Almeida et al. (2012) find that constrained firms, or firms vulnerable to refinancing at the peak of the financial crisis, reduce investment spending and bypass attractive investment opportunities. Ivashina and Sharfstein (2010) show that firms draw down credit lines during the crisis, and face difficulties in renewing the lines. Kahle and Stultz (2010) find that firms change their financial policies significantly following the onset of the crisis. Our paper complements this literature by identifying another, to our knowledge still unexplored channel through which firms can partially offset the negative effects of the credit crunch. It highlights the importance to look at other debt instruments, even if informal and not institutionalized like trade credit, to obtain a complete picture of the potential effects of a credit crunch for the real economy. Our results are consistent with Duchin et al. (2010) who find firms with high liquidity holdings do not seem to

reduce investment. We show that more liquid firms do not reduce trade credit provision to their clients.

Finally, our paper is also related to research on corporate cash holdings. Under the precautionary saving theory introduced by Keynes (1936), firms hold cash to protect themselves against adverse shocks.³ Our paper provides further evidence on the precautionary benefits of holding cash when credit tightens and firms are financially constrained or highly dependent on external finance.

The remainder of the paper is organized as follows: In Section 2 we explain our main hypothesis, the empirical strategy, and how we deal with alternative hypotheses. In Section 3 we discuss the data collection process. Section 4 presents the benchmark findings using the complete sample of suppliers, without information about their clients. In Section 5 we present and discuss the main results of the paper which are based on the supplier-customer matched sample, and simultaneously control for demand and supply of trade credit. In Section 6, we complement our previous results by focusing on the use (accounts payable) rather than the provision of trade credit (accounts receivable). Section 7 extends the period analyzed to year 2010. Finally, we conclude in Section 8.

2. Hypotheses and empirical strategy

Our main hypothesis is that cash-rich suppliers are ready to support their clients' needs for credit in times when other sources of external finance are scarce. We base this idea on several streams of the trade credit literature. A first set of theories claims that

³ There is a large literature consistent with this theory. See for example Opler, Pinkowitz, Stulz and Williamson (1999), Almeida, Campello and Weisback (2004), Faulkender and Wang (2006) and Acharya, Almeida and Campello (2007).

suppliers have an implicit stake in the survival of their clients, implying that they are willing to provide financial support to customers in difficulties (Wilner, 2000; Cuñat, 2007). For suppliers, it is profitable to lend to customers as long as the discounted value of all future rents obtained from continuing the commercial relationship with the client is large enough to offset the opportunity cost of financing the loan.

Other theories argue that clients resort to trade credit when there is rationing in bank markets (Biais and Gollier, 1997; Burkart and Ellingsen, 2004). When liquidity is relatively unrestricted, customers prefer to finance themselves through cheaper bank debt. However, as liquidity dries up, buyers are rationed by banks and they must complement their financing with trade credit. In these models, suppliers are able to extend trade credit because they have an advantage to overcome moral hazard and asymmetric information frictions with respect to banks. Moreover, suppliers obtain a markup on trade credit over their funding costs, which makes the extension of trade credit profitable from the supplier' perspective.

These theories have different implications depending on suppliers' funding position, and in particular, on their opportunity cost of funds. For example, the model by Cuñat (2007) implies that suppliers with relatively high cost of funds will offer less trade credit, because they discount future rents at a higher rate. In a similar fashion, profits from intermediating credit from banks to their customers are lower for suppliers that are constrained in the credit markets. Assuming that the crisis represents a shock to the external finance premium (Gertler and Lown, 1999), these models generate heterogeneous effects regarding a supplier's decision to extend trade credit during the crisis. On the one hand, cash-poor firms and firms that depend more on external financing

will be disproportionately impacted by higher funding costs and hence they will reduce trade credit offered to a greater extent during the crisis. On the other hand, the funding cost of lending to clients by cash-rich suppliers will be largely unaffected during the crisis as they could use internal resources to finance accounts receivable. This observation gives us the framework to formulate our main hypothesis: cash-rich firms are able to continue to provide trade credit to their clients during the crisis while cash-poor firms reduce the amount provided.

To test this hypothesis we employ a differences-in-differences approach in which we compare the trade credit supplied by firms before and after the start of the crisis as a function of their liquidity positions. Inferences could be confounded, however, if either (i) the variation in firms' liquidity positions as the crisis unfolds is endogenous to unobserved motives, unrelated to inter-firm liquidity provision, leading firms to change the proportion of trade credit offered to their clients, or (ii) the demand for trade credit by clients varies as a function of their suppliers' liquidity.

We design our specifications in a way that addresses these fundamental issues. To mitigate the potential endogenous variation in the suppliers' liquidity positions, we follow an identification strategy similar to Duchin et al (2010) and measure these variables during the year previous to the start of the crisis. To control for demand-side factors, we focus the core of our analyses on a sample of suppliers matched with their main clients, and make supplier-client relationships our unit of observation. We then regress firm-level quarterly measures of trade credit offered by suppliers on an indicator variable for whether the quarter in question is after the onset of the crisis, and on the interaction of this indicator variable with the supplier's financial position measured one

year prior to the start of the crisis. We control for supplier-client relationship (pairs) fixed effects and time- varying supplier and client characteristics that could affect the amounts of trade credit. The fixed effects subsume the level effect of the financial position of the suppliers (because the financial position is only measured once per relationship), and control for all sources, observed and unobserved, of time-invariant cross-sectional differences in firm behavior. In some of the analyses, we replace the pairs fixed effects by client-time fixed effects, which allows controlling for time-*varying* client unobserved heterogeneity.

Our basic specification can be written as follows:

$$AR_{it} = \beta_{ij} + \beta_1 \cdot CRISIS_t + \beta_2 \cdot CRISIS_t \cdot LIQ_{i,t*} + \beta_3 \cdot X_{it-1} + \beta_4 \cdot X_{jt-1} + \beta_5 \cdot w_{ijt} + \alpha_{ij} + \varepsilon_{ijt} \quad (1)$$

In the above equation, AR_{it} refers to the total amount of accounts receivable divided by sales in supplier i 's balance sheet.⁴ By scaling this measure by the flow variable sales, we control for the reduction in economic activity that is commonly associated with crises. $LIQ_{i,t*}$ denotes the suppliers' liquidity positions measured a year previous to the start of the crisis. The indicator variable $CRISIS_t$ takes the value of one during the financial phase of the crisis, specifically from July 1, 2007 to June 30, 2008, and it captures the drop in the supply of bank credit following the onset of the crisis. Our focus shall lie on the coefficient for $CRISIS_t$ and its interaction with the liquidity position of the supplier, $LIQ_{i,t*}$. According to our main hypothesis we expect to obtain a positive coefficient on this interaction term.

⁴ Ideally the dependent variable should be the amount of sales that supplier i finances to client j through trade credit. As we explain in the data section, we do not have this information. By leaving the dependent variable constant for each supplier, we are implicitly assuming that suppliers finance the same fraction of sales to each of its customers.

Our main measure for liquidity before the crisis, LIQ_{it^*} , is given by the firms' cash reserves scaled by total assets.⁵ Because firms hold cash to support the day-to-day operations, we also consider the excess cash holdings of the firms, defined as the difference between the actual cash holdings and the “optimal” cash holdings. We follow research by Opler et al. (1999) and Dittmar and Mahr-Smith (2007) and define excess cash as the difference between actual and predicted cash in the following model:

$$\begin{aligned} \ln(cash)_{it} = & \alpha_0 + \alpha_1(M/B)_{it} + \alpha_2 SIZE_{it} + \alpha_3 NWC_{it} + \alpha_4 CF_{it} + \alpha_5 CAPX_{it} \\ & + \alpha_6 DEBT_{it} + \alpha_7 CF_Volatility_{it} + \alpha_8 DIV_Dummy \\ & + Year_Dummies + \varepsilon_{it} \end{aligned} \quad (2)$$

To complement our results, we also analyze whether suppliers used their lines of credit (LOC) to increase the trade credit provided to their clients. Because cash and LOC are imperfect substitutes (Sufi, 2009; Flannery and Lockhart, 2009; Lins et al., 2010), we construct a liquidity measure that adds to the unused portion on all LOC to a given firm the cash stock available before the crisis. We measure all liquidity variables at t^* = the end of the second quarter of year 2006, i.e. one year previous to the financial crisis, to reduce concerns that the variation in firms' liquidity positions as the crisis unfolds is endogenous to unobserved motives, unrelated to inter-firm liquidity provision, that also lead to changes in the ratio of accounts receivable to sales. Finally, to reduce endogeneity concerns we use an industry level measure of dependence on external finance, as in Rajan and Zingales (1998).

⁵ We focus on cash rather than on cash flows because a stock measure like cash measured prior to the crisis is a more appropriate proxy for liquidity available during the crisis than a flow measure such as cash flow. As a robustness test, we have performed all analyses controlling also for cash flows and the results (unreported) are qualitatively unchanged.

In our models we include controls accounting for the supply of trade credit, X_{it} , as well as for the demand for trade credit, X_{jt} . Vector X_{it} includes supplier's size, age, net profit margin, sales growth, total debt, net worth, Tobin's Q, tangible assets and dummies for the different buckets of long term ratings. Vector X_{jt} includes client's size, sales growth, leverage, market share, net profit margin, cash, dummy for the existence of a bond rating, and access to lines of credit (see Petersen and Rajan, 1997 and Burkart, Ellingsen and Giannetti, 2011). We also control for w_{ij} , the ratio of sales to client j to total sales of supplier i , which measures the client's importance for a given supplier. α_{ij} denotes the pairs fixed effects.

We scale all liquidity measures, tangible assets, net worth, and cash flow, tangible assets, current assets, and total debt by total assets. To avoid simultaneity, we lag all control variables by one quarter.

3. Data

Our baseline sample consists of US-incorporated, non-financial firms from Compustat's quarterly database with available balance sheet data between the third quarter of 2005 and the fourth quarter of 2010. We exclude firms with non-negative values of total assets (atq), cash ($cheq$), and sales ($saleq$), those reporting cash values greater than total assets, and those with missing values of accounts receivable ($rectq$), our main dependent variable. As is the standard practice in recent related literature, we also eliminate firms with market capitalization less than \$50 million, as well as firms whose book value of assets is less than \$10 million, and those displaying asset or sales growth

exceeding 100. The resulting sample consists of 24,733 firm-quarters, corresponding to information on 2,250 firms.

We merge information on the existence of drawn/undrawn balances in any line of credit using CapitalIQ (CIQ). CIQ compiles detailed information on capital structure and debt structure by going through financial footnotes contained in firms' 10K filings for the SEC. In these filings, firms provide detailed information on the drawn and undrawn portions of their lines of credit either in the footnotes explaining debt obligations or in the discussion on liquidity and capital resources. From CIQ we obtain information on LOC for a total of 19,432 firm-quarters.

Finally, we collect information about the firms' key customers using the Customer Segment File in Compustat. In accordance with SFAS Nos. 14 and 131, public firms have to disclose the identity of and total amount of sales to customers whose purchases represent more than ten percent of the firm's total annual sales.⁶ We search the customers' names within Compustat to obtain balance sheet information for the clients. The main advantage of using this data is that the analysis is based on actual supplier-customer relationships, so we can control for supply and demand factors. However, the matched sample has some limitations. For example, data on key clients contain information only for clients representing at least 10% of supplier sales, so suppliers with diversified sales portfolios do not disclose some of their most important clients. Further, some suppliers report generic client names which cannot be matched with Compustat data. For the remaining firms that do list names of actual clients, we use data mining techniques, like algorithms that match the number of common characters across names, to

⁶ The data set does not contain information on the amount of trade credit given to each customer. We perform all our analyses assuming that suppliers give the same proportion of credit to each of their clients.

match these names to companies whose data are available in Compustat. There are few perfect string matches for the client names. We manually match the remaining names to complement our database.⁷ We are unable to find matches for many clients, for example small unlisted firms, foreign firms, or firms for which balance sheet information is not available in Compustat for the period in which they were reported to be clients.⁸ Overall, with this procedure we find matches for 21,684 client-supplier quarter-pairs, of which 9,368 have non-missing values in all relevant variables and can be used in the regression analyses. Table 1 contains key descriptive statistics for the unmatched Compustat sample (Panel A) and the supplier-customer matched sample (Panel B). Suppliers in our matched sample are around one fourth of Compustat firms, while clients are roughly 13% of Compustat firms. Table 1 shows that the median supplier in our matched sample is not very different to the median Compustat firm; however Compustat firms are somewhat smaller than the median client in the matched sample.

4. Baseline results: Supplier's liquidity position and trade credit provision

We start our analysis by estimating Eq. (1) above on the baseline unmatched sample. Using the complete sample has the advantage of representativeness and, although we cannot explicitly control for demand factors, it provides motivation for the rest of the analyses. Results for these regressions are contained in Table 2. We focus our attention on our main hypothesis that liquid firms increased trade credit provision more during the crisis relative to less liquid firms, i.e. on the coefficient of the crisis dummy interacted

⁷ The procedure we follow is similar to the one described in Fee and Thomas (2004).

⁸ Key customer data is annual. To match this with Compustat quarterly data we assume that key customers do not change during the four quarters of the fiscal year.

with the liquidity measures. Our measure of firm liquidity in columns 1 and 2 are, respectively, cash reserves and excess cash, both scaled over assets. Their interaction with the crisis dummy is positive and significant in both cases, implying that firms with more cash reserves are able to offset the observed overall negative effect of the crisis on trade credit.⁹ This is our main result: cash-rich firms *increase* the amount of trade credit provided to their clients during the first phase of the financial crisis. The increase is significant: the coefficient in column 1 suggests that a one standard deviation increase in cash reserves implies an increase of quarterly accounts receivable to sales by 0.5 percentage points during the crisis. On a yearly basis, it means that the average firm increased client financing by 9.8 million. This amount represents around 11% of the yearly limits in lines of credit of an average firm.

Recent literature on corporate liquidity management provides evidence that the use of revolving lines of credit is generally jointly determined with cash holdings, suggesting that a firms' effective liquidity position is composed of internal cash reserves and external cash that can be obtained from drawing down an existing line of credit.¹⁰ To explore the role of lines of credit, in columns 3 and 4 we run specification (1) using two measures of liquidity that account for the substitutability of cash with lines of credit:¹¹

⁹ The negative coefficient for the crisis dummy implies that accounts receivable as a fraction of sales dropped on average by 1.5 percentage points during the first year following the start of the crisis in July 2007 for firms with zero cash. This decline is mitigated for firms holding positive cash.

¹⁰ Sufi (2009) shows that the availability of a line of credit depends on the ability of the firm to maintain high cash flows. Firms with high cash flow obtain a line of credit and therefore hold less cash than firms with low cash flow that cannot secure lines of credit and need to hold more cash. The recent related literature pays renewed attention to the use of lines of credit for corporate liquidity and risk management. For instance, Acharya et al.(2011) establish a relationship between a firm's systemic risk and its usage of cash vs. credit lines. Disatnik et al. (2012) analyze the joint use of cash, lines of credit and derivatives for cash flow hedging.

¹¹ Cash and lines of credit are imperfect substitutes. Cash is held on a firm's balance sheet and is readily available. A line of credit is a commitment credit contract that allows firms to draw down on demand from the credit line up to the pre-specified credit limit provided that no credit line covenant is violated.

cash plus LOC limit in column 3, and cash plus undrawn LOC balances in column 4. Adding measures of external liquidity to cash increases both the significance and the economic magnitude of the positive effect of liquidity. Firms with unused funds in their lines of credit provided more credit to their clients during the crisis than what is predicted when we use only cash reserves to measure a firm's liquidity position, which highlights the importance of both cash and lines of credit for trade credit provision.

We next explore firm heterogeneity by exploiting the cross-sectional differences across firms. Recent studies argue that some firms tap the bond markets to partially offset the decrease in credit supply occurring during downturns (Becker and Ivashina, 2011; Adrian et al., 2012). In columns 5 and 6 we divide the sample into firms with and without bond rating, respectively, to analyze liquidity provision among these two subsets. We find that only rated cash-rich firms increased their accounts receivable. The coefficient for cash*crisis for this subset of firms is 0.13 and highly significant, suggesting that liquidity provision enabled redistribution of funds obtained through bond markets to clients more affected by the credit crunch. The estimated coefficients imply that the ratios of cash reserves to assets required to totally mitigate the decline in accounts receivable is 17.7% for rated firms, and 78.4% for non-rated firms. The last rows of the table provide the F-statistic and the p-value associated to the test of equality of the interaction coefficients across the two subsamples: the null hypothesis is rejected, suggesting that the observed differences among firms with and without bond rating are statistically significant. These results are fully consistent with the redistribution theory of trade credit (Meltzer, 1960; Petersen and Rajan, 1997; Calomiris, Himmelberg, and Wachtel, 1995;

Nilsen, 2002). Similarly, Burkart and Ellingsen (2004) argue that unconstrained firms with better access to funds should offer more trade credit.

We next strengthen the identification of a supply shock and analyze inter-firm liquidity provision during the crisis using a measure of external finance needs: the Rajan and Zingales (1998) index of external finance dependence (EFD from now on).¹² The main advantage of using the EFD measure is that it is defined at the industry sector level as opposed to the firm level; therefore it is less endogenous than the above firm-level measures. In columns 7 and 8 we divide the sample of firms into low EFD and high EFD firms, respectively, and run regression (1) on each subsample. We find that firms with more cash are significantly more likely to extend more credit to their clients, but *only* among the firms in industries with low dependence of financing from external sources. In the last row we observe that the null hypothesis of equality of interaction coefficients is rejected, further strengthening our interpretation of a causal effect of a supply shock.

The difference in economic and statistical significance of the coefficients in columns 1 and 2 with respect to those in columns 3, 4, 5, and 7 suggests that having cash is necessary but not sufficient to provide liquidity to clients. Firms require additional access to external funding or to capital markets to be able to provide trade credit. This result highlights the importance of accounting for external liquidity available though pre-

¹² The EFD index is defined as the proportion of capital expenditures in excess of cash flows within firms of the same industry. A positive EFD means that the cash flow generated by the firms in the industry is not sufficient to cover the capital expenditures, and therefore, firms have to issue debt or equity to finance investments. A negative EFD value indicates that firms have free cash, and therefore less need for external financing. We use Compustat firms between the years 1980 and 1996 and use firms that have been on Compustat for at least 10 years to calculate the EFD index. The reason for this choice is to capture firms' demand for credit and not the amount of credit supplied to them. We sum across all years each firm's total capital expenditures minus cash flows from operations and then divide it by total capital expenditures. Next, we aggregate the firm-level ratios of external financial dependence using the median value for all firms in each two-digit Standard Industrial Classification (SIC) category.

committed lines of credit, as well as the important role played by bond markets to mitigate the negative effects of the credit crunch.

One possible concern of our previous results is that they could reflect demand factors, rather than supply effects. If the first year of the crisis entails an economy-wide demand shock instead of a supply shock as we have assumed so far, our inferences could be confounded for two reasons. First, year-before cash reserves could serve as a proxy for the susceptibility to a demand shock if, for instance, firms accumulate cash reserves in anticipation of increased demand for credit by their clients during the crisis. Second, accounts receivable during the 2007 crisis could grow because clients are not being able to pay their debts to suppliers, rather than because suppliers are providing liquidity to their clients.

To address this concern, we repeat our base specification for the negative demand shock caused by the events of September 11, 2001. Tong and Wei (2008) explain that 9/11 had both a significant and almost entirely demand-side effect on the economy. If our results are caused by demand, rather than supply effects of the crisis, then we would expect to find results similar to our main results following this significant economy-wide negative demand shock. In columns 9 and 10 we repeat the estimations of columns 1 and 4, respectively, on the period following the 9/11 shock. Consistently with a negative demand shock, overall accounts receivable fall (or stay constant) after 9/11. However, unlike our main results, we find that year-before cash reserves, if anything, are *negatively* related to accounts receivable. Similarly, the availability of liquidity through a LOC before the crisis does not lead to a higher provision of credit through accounts receivable. These results suggest that the positive relationship that we found in the 2007-2008

financial crisis between inter-firm credit provision following the supply shock and the pre-crisis liquidity reserves should be stronger in the absence of demand effects.¹³

Regarding the control variables, our results suggest that firms that have better access to financing offer on average more trade credit: the coefficients for the logarithm of assets and for rating dummies (untabulated) are positive while the coefficient for leverage is negative. These results suggest that firms with larger debt capacity are in a better position to increase the provision of trade credit to their clients, i.e. they have access to public debt markets and are less bank dependent. Having controlled for size and debt capacity, we find a negative coefficient for age suggesting that established firms have less incentives to extend trade credit, as their need to certify the quality of their goods or boost their sales is lower. This is consistent with the results of Burkart, Ellingsen and Giannetti (2011). We also find a negative coefficient for sales growth, consistent with Petersen and Rajan (1997) and suggesting that firms with slow growth could use extension of trade credit to attempt to maintain their sales. Similarly, the coefficient for Tobin's Q is also negative, suggesting that firms with limited real investment opportunities invest more in client relationships through the extension of trade credit. Finally, as in Burkart, Ellingsen and Giannetti (2011), we find that firms with lower net profit margins and smaller ratios of fixed to total assets extend more trade credit, possibly in an attempt to increase their margins by attracting new clients.

¹³ In the Appendix we perform several other robustness checks for our results. These include: (i) scaling all right hand side variables by assets net of cash and assets net of accounts receivable, (ii) changing the estimation sample by adding and deleting four quarters to our baseline sample, (iii) changing the identification year for measurement of the liquidity variables to up to 12 quarters before the start of the crisis, and (iv) scaling the dependent variable by total assets, a stock measure, rather than by a flow measure like sales. Our results are qualitatively unchanged.

5. Analysis of supplier-customer relationships

One of the main confounding factors of the results in the previous section is that we cannot directly control for demand effects. If, for example, ex-ante liquid suppliers are systematically matched with customers that are unwilling to pay on time, it is possible that the previous results capture a demand-driven increase in trade credit offered. To rule out that our results are driven by the demand for trade credit which forces suppliers to offer trade credit, in this section we run the regressions of Eq. (1) on the supplier-client matched sample. In this sample our unit of analysis is a supplier-customer relationship. Therefore, we are able to control for the demand for trade credit by adding client characteristics and for time invariant supplier-client characteristics by including pairs fixed effects.¹⁴ Moreover, the matched sample allows us to explore the redistribution theory of trade credit, as we can verify whether suppliers of firms with reduced access to external financing are extending relatively more trade credit as a function of their liquidity.

5.1. *Supplier's cash and trade credit provision*

Our first set of results on the matched sample can be found in Table 3. In this table suppliers' liquidity is measured with cash reserves. Column 1 contains the benchmark within-relationship effect of the credit crisis on liquidity provision as a function of suppliers' cash, without controlling for either supplier or client characteristics. Consistently with our main hypothesis we find that the interaction term cash*crisis is positive. The positive effect of liquidity on trade credit provision is

¹⁴ Few other papers have analyzed trade credit using supplier-customer pairs, notably Shenoy and Williams (2011) who analyze the determinants of trade credit using this matched supplier-customer data, and Klapper, Laeven and Rajan (2012) who analyze a cross section of trade credit contracts in the United States and Europe. Our paper differs from theirs in that our focus is on the financial crisis and supply shocks.

enhanced when we control for supplier and client time-varying observed characteristics, in column 2 (our baseline model). The coefficient in column 2 implies that a one standard deviation increase in cash increases quarterly accounts receivable to sales by 1.6%. On a yearly basis, this implies an increase of financed sales of 24.6 million dollars for the average firm, which is equivalent to around a quarter of the yearly limit in lines of credit for the average firm in our sample.

In columns 3 to 7 we explore whether access to external financing affects inter-firm liquidity provision. In column 3 we add as a control the client industry-level EFD measure.¹⁵ The coefficient for this variable is positive and highly significant, implying that trade credit provision is greater when clients have higher external financing needs. The coefficient implies that on average suppliers finance 5.1 percentage points more of their sales to clients in industries with high financing needs compared to clients in low EFD industries.

We next explore the differences in liquidity provision during the crisis according to clients' EFD. In columns 4 and 5 we divide the supplier-client pairs according to whether the EFD of the client is below or above the median, respectively, and run Eq. (1) on each subsample. We find that suppliers with high cash reserves increased trade credit provision only when their clients are in high EFD sectors. To illustrate the magnitude of the effect, we find that a one standard deviation increase in year-before cash reserves implies an increase in trade credit of 2.6% of quarterly sales points for external finance dependent clients, and just 0.4% of quarterly sales for a non-dependent client. On a

¹⁵ Since client EFD is only measured once for each supplier-customer pair, we interact it with the crisis dummy to estimate its effect on trade credit extension of the supplier; otherwise it would be subsumed by the pair fixed effects.

yearly basis, this implies an increase of financed sales of 36 million dollars and 6.5 million dollars, respectively.

This evidence is consistent with the redistribution theory of trade credit. The difference between the coefficients of cash*crisis is statistically significant, as shown in the last two rows. In columns 6 and 7 we perform a similar test but using supplier's EFD to divide the sample into two groups. Confirming the results for the un-matched sample of suppliers of the previous section, we only find the coefficient of cash*crisis significant for the sub-group of low EFD suppliers. In unreported results we also subdivide the sample into 4 groups according to the cross-tabulation of client and supplier EFD, and find that the coefficient for cash*crisis is significant only within relationships with low EFD supplier and high EFD client.¹⁶ These results show how trade credit flowed from low EFD suppliers to high EFD clients during the crisis, which again supports the redistribution theory of trade credit.

The signs of the supplier control variables in columns 2 to 7 are generally consistent with the results obtained for the unmatched supplier sample. Client controls, on the other hand, are largely non significant; however the signs are roughly consistent among the different specifications. These coefficients show that trade credit flows from relatively old firms with lower growth rates to smaller, less liquid clients, and to firms with positive growth. These results suggest that suppliers are supporting the most constrained clients which have better prospects. Results also show that suppliers extend credit to clients with more bargaining power (as shown by the negative sign for client's

¹⁶ In particular, the crisis*cash coefficient is equal to 0.106 for the subsample of high EFD clients and low EFD suppliers and it is statistically significant at 5% confidence level. We also obtain a sizable, although insignificant, coefficient equal to 0.0798 when both supplier and client are in a high EFD industry. The coefficients for the remaining two groups are positive but close to zero.

net profit margin), and to clients representing a lower proportion of the suppliers' sales (client's importance). We must recall that by construction we only observe clients whose sales represent more than 10% of the suppliers' total sales, so this result could be due to a nonlinearity of client importance on trade credit extension.

Next, in column 8 we strengthen our identification strategy by using client-quarter fixed effects instead of pairs fixed effects. We profit from the fact that our sample includes the same firm as client to several suppliers. That is, our unit of analysis is now a client-quarter and we analyze trade credit provision by suppliers with differing cash positions to the same client. By exploiting the within customer-quarter variation, this specification controls for time-varying client unobserved heterogeneity, and so has the crucial advantage of better controlling for demand effects. Note that the presence of time-client fixed effects subsumes all time varying client characteristics, as well as the recession dummy. We find that better controlling for demand effects doubles the effect of cash on inter-firm liquidity provision.

As a final test for our identification strategy, in column 9 we perform a placebo test using the supplier-client matched sample, and regressing Eq. (1) on the period following the demand crisis of the 9/11 episode. The coefficient is not significant, supporting the idea of a supply shock during the 2007-2008 crisis.

5.2. *Supplier's liquidity, client's liquidity, and trade credit provision*

In Table 4 we further explore the inter-firm liquidity provision as a function of the supplier's and client's access to external financing, by using the firm-level measures of internal and external liquidity introduced in the previous section. More precisely, we measure supplier's liquidity using cash in column 1, excess cash in column 2, cash plus

LOC limit in column 3, and cash plus undrawn LOC balances in columns 4 and 5. Specifications in Panel A include relationship fixed effects, as well as all client controls as in column 2 of Table 4 (unreported). Additionally, in Panel A we control for client liquidity with client cash to assets in columns 1 to 4, and the ratio of cash plus undrawn LOC balances to assets in column 5.

According to the redistribution theory of trade credit, clients with access to a pre-committed LOC should demand less trade credit, because they have more liquidity available, and consequently are less constrained (Sufi (2009) shows that access to LOC is an inverse measure of financial constraint). Results confirm this intuition and show how liquidity flows from the most liquid firms to firms with no lines of credit: the coefficient for supplier liquidity is positive as in Table 3, while the one for client liquidity is negative in all specifications and significant in columns 2 and 5. For example, the coefficients in column 5 suggest that a one standard deviation increase in supplier's cash implies an increase of trade credit to sales of 1.7 percentage points, while a one standard deviation increase in client's cash plus undrawn balances in their LOCs implies a supplier's decline of trade credit to sales by 2.5 percentage points.

Panel B of Table 4 repeats the specifications 1 to 4 of Panel A, but replacing pairs fixed effects by client-quarter fixed effects to control for time varying unobservable variation in demand for trade credit. The fixed effects subsume all client controls (including client LOC access and external liquidity), but allow us to estimate the effect of supplier liquidity, which we find to be positive and very significant for all measures. These results hence confirm our main hypothesis that most liquid firms increase the amount of trade credit offered during the crisis.

5.3. *Supplier's debt and trade credit provision*

We next extend our analysis and examine liquidity provision during the crisis as a function of several measures of pre-crisis supplier leverage. We are particularly interested in examining whether firms with high proportions of short term debt (i.e. debt maturing within one year) were equally able to increase liquidity provision as firms financed primarily through long term debt. As rolling over the debt during the credit crunch potentially entailed a notable reduction of liquidity, we expect firms with high proportions of short term debt to be less able to extend liquidity to their clients than those relying more in long-term debt.

To explore this idea, in Table 5 we run Eq. (1) on the matched sample replacing the suppliers' liquidity measures with: short term debt over assets in column 1, long term debt to assets in column 2, total debt to assets in column 3, and net short term debt (short term debt net of cash) over assets in column 4. As before, we measure debt positions one year before the start of the crisis.

Results in Table 5 show that firms with large portions of short term debt or net short term debt significantly *reduced* the trade credit provision during the crisis. The coefficients for total debt and long term debt are negative but not statistically significant. Because short term debt and net short term debt represent a potential decrease in liquidity when refinancing is difficult, whereas long-term debt does not, these findings reinforce the interpretation of our main results as a supply effect.

5.4. *Suppliers' liquidity and clients' debt in trade credit*

We now change our point of view and analyze firms as recipients of trade credit (i.e. as clients rather than suppliers) to examine the demand for trade credit as a function of suppliers' liquidity. If the most liquid firms are providing liquidity to their clients, then we should observe that clients matched with the most ex-ante liquid suppliers increase their debt in accounts payable during the crisis. We use a supplier-customer pair as unit of analysis and run a modified version of regression (1) using AP_{jt} , the ratio of accounts payable to the cost of goods sold, as the dependent variable.¹⁷ In this specification we include controls for clients' demand for trade credit, such as size, age, sales growth, total debt, current assets and a dummy for no long term debt rating (Petersen and Rajan, 1997; Burkart, Ellingsen, and Giannetti, 2011). We scale our constraint measures, current assets, and total debt by total assets. Importantly, we also control for the supplier's ability to supply trade credit. The key variable, as before, is the interaction term between the liquidity position of the supplier (measured one year prior to the crisis) and the indicator variable $CRISIS_t$. Additional supplier's controls include size (scaled by assets), sales growth, leverage, and market bargaining power (measured by net profit margin). We also include as control variable w_{jit} , the importance of the supplier for each client, calculated as the ratio between the purchases from each supplier to the total cost of goods sold of the customer. In all specifications we include relationship fixed effects that control for unobserved time unvarying characteristics at the supplier-customer relationship level. The resulting Eq. is hence the following:

¹⁷ When multiplied by 360, this ratio is often interpreted as the number of days a firm takes to pay off their debts to suppliers. As was the case for the receivables ratio, by scaling accounts payable by a flow variable we control for the reduction in economic activity that is commonly associated with crises.

$$AP_{jt} = \beta_{ij} + \beta_1 \cdot CRISIS_t + \beta_2 \cdot LIQ_{i,t}^* \cdot CRISIS_t + \beta_3 \cdot Z_{it-1} + \beta_4 \cdot Z_{jt-1} + \beta_5 \cdot w_{jit} + \alpha_{ij} + \varepsilon_{ijt} \quad (3),$$

where subindex i identifies the supplier while subindex j denotes the customer.¹⁸

Table 6 contains the coefficients for these regressions. Given that we are using a new dependent variable, we establish the basic patterns in the data in column 1 by estimating a basic model that includes only the crisis dummy and all client and supplier controls, plus a constant and pair fixed effects. We find that accounts payable as a fraction of cost of goods sold decreased on average by 2.68% during the first year following the start of the crisis in July 2007. In the rest of the columns we include different measures of supplier's liquidity: cash reserves (column 2), excess cash (column 3) supplier's line of credit dummy (column 4), cash plus LOC limit (column 5), and cash plus unused LOC balances (column 6). In all cases the coefficient for the interaction term liquidity*crisis is positive and significant, implying that firms with the most liquid suppliers increased debt in trade credit during the crisis. The estimates in column 4 suggest that a one standard deviation rise in supplier's cash implies an increase of client's use of trade credit by 3.3% of cost of goods sold. This increase represents 4.7% of the unconditional mean of trade credit used to cost of goods sold per quarter, which is 69%. This finding provides once again support for our main hypothesis from the demand side point of view: suppliers' liquidity is a key determinant of their ability to finance their clients.

¹⁸ Similarly to the previous analysis, the dependent variable in this case is total accounts payable instead of accounts payable from each supplier. Unfortunately, we do not have this information. By leaving the dependent variable constant for each customer, we are implicitly assuming that customers receive the same fraction of financing from each of its suppliers.

6. Trade credit debt and firm credit constraints

Several theories of trade credit predict that financially constrained firms should increase their demand for trade credit during crises.¹⁹ In this section we test this demand hypothesis. To this end, we view firms as the recipients of trade credit (as in Table 6) and analyze their debt in accounts payable as a function of their credit constraints. Specifically, to assess the role of constraints on trade credit demand we use the supplier-client relationship data set and add to specification (3) a measure of client's financial constraints (measured at the second quarter of 2006, to avoid endogeneity concerns) interacted with the crisis dummy, $CONS_{j,t} * CRISIS_t$. The coefficient of this interaction term shall indicate whether the most constrained firms increased their debt in trade credit during the crisis. Moreover, by adding the interaction of supplier's liquidity with the crisis dummy in the specifications, we are able to provide a further test for the supply hypothesis. We use the following measures of financial constraints: Kaplan-Zingales (1997) index ($KZind_{jt}$), the Whited-Wu (2006) index ($WWind_{jt}$),²⁰ the dividend payout ratio (an inverse measure of financial constraints), and a dummy containing a one if the firm does not have a rating for their long term. Following Sufi (2009), we also consider as additional (inverse) measures of constraints the LOC limit and undrawn balances in

¹⁹ For example, the redistribution theory of trade credit implies that suppliers with better access to funding use trade credit as a means to distribute credit to constrained firms. Similarly, the model by Burkart and Ellingsen (2004) implies that the use of trade credit is countercyclical for bank constrained firms that do not exhaust their trade credit limits. In a nutshell, the mechanism is the following. In a downturn, constrained firms cannot obtain bank credit and therefore they increase trade credit usage; that is, constrained firms substitute the drop in bank credit with trade credit. On the other hand, unconstrained firms in the bank credit market are unaffected by the downturn since they have not exhausted their bank credit limits.

²⁰ We calculate the indices with the following formulas:

$$KZind_{jt} = -1.002 \cdot CashFlow_{jt} + 0.283 \cdot Q_{jt} + 3.319 \cdot DEBT_{jt} - 39.368 \cdot DIVIDEND_{jt} - 1.315 \cdot CASH_{jt}$$

$$WWind_{jt} = -0.091 \cdot CF_{jt} - 0.062 \cdot DIVIDEND_Dummy + 0.021 \cdot LongTerm_DEBT_{jt} - 0.044 \cdot \log(SIZE)_{jt}$$

$$+ 0.102 \cdot Industry_SalesGrowth_{jt} - 0.035 \cdot Sales_Growth_{jt}$$

LOC. Finally, we also use the EFD of the client's industry as a more exogenous measure of constraints.²¹

The results of these regressions are in Table 7. Specifications in Panel A include pairs fixed effects to control for unobservable time-invariant relationship characteristics, as well as supplier and client controls. In Panel B, we include client controls and account for all unobservable time-varying supplier characteristics by including supplier-quarter fixed effects (which subsume all supplier characteristics including liquidity). Results show that accounts payable increased for the most constrained firms, consistently with an increased demand for trade credit by constrained firms. This is true independently of the measure of constraints chosen: coefficients have the expected sign and are statistically significant in almost all specifications. Moreover, in Panel A we observe that accounts payable increased during the crisis for firms having the most liquid suppliers. For example, the coefficients in column 6 suggest that a one standard deviation increase in supplier's cash rises client's use of trade credit by 3.8% of cost of goods sold, while a one standard deviation increase in client's unused portion of lines of credit over assets decreases client's use of trade credit by 4.3% of cost of goods sold. This result is consistent with the redistribution theory of trade credit and complements the results of Tables 3-5 which analyze accounts receivable. Credit flows from the most liquid firms to the most constrained ones.

²¹ To provide further support for this hypothesis, we have performed two complementary (unreported) analyses. The first one analyzes suppliers' accounts receivable as a function of their clients' credit constraints, using the paired sample. We find that suppliers of financially constrained firms experienced a larger increase in accounts receivable during the crisis. The second one analyzes accounts payable using the whole sample of firms. The unmatched sample is a more comprehensive and representative data set, but it does not permit to control for supply effects. The results are fully consistent with those in the matched sample reported below and show that financially constrained firms increased trade credit usage during the crisis compared to less constrained firms. These results are available from the authors upon request.

7. Long run dynamics

7.1. Trade credit provision over the complete crisis episode and after

In this section we analyze whether liquidity provision was temporary, or whether it was a persistent phenomenon that lasted during the whole crisis episode and after. To do so, we extend our analysis to the eight quarters following the Lehman debacle in September 2008. This event caused further stress in bank balance sheets, which led to even tighter bank credit supply relative to the previous year, hence potentially to an enhanced role of liquidity provision. However, this drop in bank credit supply was countered, on the one hand, by an acute drop in economic activity leading to lower demand for credit, and on the other, by a slow rebound in the bond and stock markets, especially at the aftermath of the crisis (Becker and Ivashina, 2011; Adrian et al, 2012).

We start our analysis of the net effect of these countervailing forces on trade credit provision by sorting firms according to their pre-crisis cash stock terciles, and analyzing the evolution of their accounts receivable. Our untabulated results show that the growth in accounts receivables to sales for cash-rich firms peaked during the 2007 financial crisis, and continued to increase (but at a slower rate) the year after. At the aftermath of the crisis, however, accounts receivable to sales decreased for firms in all three cash percentiles. On the other hand, cash stocks decreased the most for firms with the highest increase in accounts receivables during the 2007 crisis. Consistently with cash hoarding found in previous studies (Ivashina and Scharfstein, 2010), cash reserves grew for all firms during the 2008 crisis and after, albeit at a much higher rate during the aftermath of the crisis. This preliminary analysis suggests that cash-rich firms initially

financed the increase in accounts receivable with cash. However, as their cash stocks began to deplete and the shock to their clients was perceived as systematic rather than idiosyncratic, firms began to hoard rather than invest cash on their clients.

To formalize this analysis we run Eq. (1) over an estimation sample running from the third quarter of 2005 to the second quarter of 2010. We separate the effects of the different phases of the crisis by adding to the specification in Eq. (1) a dummy containing a one for the period going from the third quarter of 2008 to the second quarter of 2009 (Crisis 2008), and a dummy containing a one for the period going from the third quarter of 2009 to the second quarter of 2010 (Post-Crisis). We interact each of these time dummies with several measures of liquidity: cash, excess cash, and cash plus undrawn balances in LOC. Results are contained in Table 8.²²

Columns 1 to 3 of Table 8 show that the positive and significant effect of liquidity on the accounts receivables to sales ratio for the financial stage of the crisis (Crisis 2007*Cash) is mitigated over the 2008 crisis and subsequently reversed to a negative one at the post-crisis period. Once we control for demand, as in columns 4 to 6, we continue to find a positive and significant effect of liquidity during the year following the Lehman debacle, which disappears in the post-crisis. Combined, these two sets of results suggest that demand effects were very strong as the crisis intensified in autumn 2008, leading to the observed negative coefficients for the interaction of cash with the Crisis 2008 dummy in columns 1-3. Once we control for this drop in demand, however, we find that inter-firm liquidity provision continued to play a role during the 2008 crisis. Accounts

²² We stress that the results of these estimations are only suggestive as the instruments for identification (liquidity measured at the second quarter of 2006) are weaker proxies of firms' liquidity for later periods.

receivable reverted to their pre-crisis levels only during the post-crisis period, coinciding with the rebound of bond and stock markets (Becker and Ivashina, 2011).

7.2. *Liquidity provision and performance*

We now assess the benefits of liquidity provision on suppliers' and clients' performance. Theory predicts that the benefits of liquidity provision are derived from the future rents of selling to a client that would otherwise be lost (Wilner 2000; Cuñat, 2007). Wilner (2000) also argues that suppliers can use liquidity provision to consolidate and possibly expand their market positions through the acquisition of dependent clients and creation of new client relationships. To the extent that only liquid suppliers are able to consolidate and expand their client relationships, this implies that suppliers extending trade credit should increase their performance. From the point of view of clients, the benefits of receiving liquidity are more clear-cut. In fact, both the models of Wilner (2000) and Cuñat (2007) assume that clients are willing to pay a higher price for trade credit to receive its benefits.

In Panel A of Table 9 we evaluate the relative changes in suppliers' performance by using a difference-in-difference approach, and regressing several measures of firm performance on a crisis dummy, and the interaction of the crisis dummy with the average quarterly accounts receivable to sales ratio during the 2007-crisis episode relative to the previous year (ΔAR), plus firm controls and fixed effects. We instrument ΔAR with supplier's pre-crisis cash stocks to capture the idea that only liquid firms that willingly provided liquidity should exhibit improved performance.²³ Because performance is measured at the firm level (not customer-supplier pair level), our unit of observation here

²³ We thank an anonymous referee for suggesting us this analysis.

is a supplier, and we run these regressions on the larger unmatched sample. To assess whether the effects on performance were temporary or permanent we run the estimations over three different time frames (i) the 2007-2008 crisis, (ii) the complete 2007-2009 crisis episode, and (iii) from the start of the credit crunch (2007q3) to one year after the crisis (2010q2). Results are consistent with an increased medium or long-term performance for firms that willingly increased their extension of trade credit to clients. Liquid firms increasing their accounts receivables to assets ratio during the crisis had better overall performance during and after the crisis, relative to their ex-ante performance. In particular, suppliers were able to significantly increase their return to sales and their net profit margins and to a lower extent also their return to assets and their EBITDA. These results are consistent with suppliers using their financial slack to consolidate their market power, possibly by stealing the market from competitors that did not have the economic means to provide liquidity. Finally, our findings of a positive effect on performance further support the idea that liquidity provision during the crisis was done willingly by suppliers, as opposed to demand-driven, thus reinforcing our identification of supply effects.

In Panel B of Table 9 we complement this performance analysis by examining whether clients receiving trade credit also improved their performance. In this case we regress several measures of client performance on a crisis dummy and the interaction of the crisis dummy with the average change in accounts receivables to sales of the clients' suppliers. As before, our units of observation are single clients; however we use information from the matched supplier-client sample to identify suppliers' increase in accounts receivable to sales. We find a positive effect in ROA, ROS and EBITDA for the

clients benefitting from the cash transfers. However, the net profit margins of clients did not increase, suggesting that only liquid suppliers managed to improve their market position by helping out their clients.²⁴

8. Conclusions

We study the effect of the financial crisis that began on August 2007 on the inter-firm provision of credit. The crisis represents an unexpected negative shock to the supply of external finance for non-financial corporations, which makes it an ideal scenario to analyze the role of alternative sources of financing when bank credit is scarce. We focus on the financial phase of the crisis, running from the third quarter of 2007 to the second quarter of 2008, where supply effects dominate. We find that trade credit given to other corporations increases (or falls more slowly) for firms holding more liquidity. Consistent with a causal effect of the supply shock, our results are stronger when we divide firms by industries according their degree of external finance dependence, and we do not find similar results following the demand shock caused by the events of September 11, 2001. Similarly, having access to external liquidity through lines of credit significantly increases inter-firm liquidity provision.

We also find that trade credit taken by constrained firms increases during this period to compensate for the scarce institutional credit. Our results imply that suppliers provide liquidity insurance to their clients whenever they experience a temporary liquidity shock and underscore their role as liquidity providers of last resort (Wilner, 2000; Cuñat, 2007). These results are consistent with the redistribution view of trade

²⁴ In untabulated results we find some evidence that the likelihood of filing for bankruptcy or being acquired as part of an M&A operation is lower for firms benefitting from liquidity provision.

credit provision (Meltzer, 1960; Petersen and Rajan, 1997; Nilsen, 2002). Our analysis after the Lehman bankruptcy in September 2008 highlights the limitations of intra-firm credit to absorb more permanent and severe shocks. Our findings provide an important precautionary savings motive for accumulating cash reserves.

As we emerge from the most severe recession since the Great Depression, many are blaming the anemic economic recovery to the lack of bank lending. Economic policies have been directed to restore the solvency of financial institutions to reestablish the flow of lending to firms and individuals. The findings of this paper highlight the importance of non-financial firms in offering substitute credit in times of financial stress and points out that policies aimed at enhancing this credit source, like trade credit insurance or guarantees, could prove more effective to foster economic growth.

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Table 1. Descriptive statistics

	A. Whole Compustat sample (Firm-Quarters)				B. Customer-supplier pairs sample (Pair-Quarters)				Comparison between sample A and B	
	N. Obs	Mean	Median	St. dev	N. Obs	Mean	Median	St. dev	Compustat Coverage (% obs)	Median A/ Median B
<i>I. Supplier Variables</i>										
Account receivables / sales	24'733	0.612	0.590	0.419	9'368	0.642	0.607	0.341	23.74%	0.983
Accounts payable / COGS	24'648	0.649	0.447	0.819	9'334	0.666	0.490	0.813	23.75%	0.905
Assets (Million US \$)	24'733	3'824	566	14'237	9'368	2'974	512	10'007	23.74%	1.037
Age (years)	24'733	20.70	16.00	13.13	9'368	19.37	15.00	12.58	23.74%	1.024
PPE / assets	24'733	0.245	0.172	0.218	9'368	0.194	0.136	0.189	23.74%	1.206
Net profit margin	24'733	0.245	0.368	1.184	9'368	0.258	0.385	1.044	23.74%	0.956
Sales growth	24'733	0.001	0.027	0.250	9'368	-0.005	0.027	0.279	23.74%	0.977
Net worth / assets	24'733	0.377	0.392	0.279	9'368	0.414	0.435	0.283	23.74%	0.915
Total debt / assets	24'733	0.197	0.158	0.206	9'368	0.182	0.131	0.201	23.74%	1.235
Tobin's Q / assets	24'733	2.034	1.605	1.331	9'368	2.101	1.638	1.386	23.74%	0.987
Liquidity variables (measured at 2006:q2)										
Cash / assets	2'250	0.199	0.116	0.214	998	0.253	0.183	0.236	22.40%	0.631
Excess cash / assets	1'999	0.129	0.052	0.229	909	0.180	0.118	0.255	23.01%	0.437
Line of credit (LOC) dummy	1'694	0.530	1.000	0.499	744	0.461	0.000	0.499	22.02%	1.183 *
LOC limit / assets	1'694	0.054	0.000	0.099	744	0.042	0.000	0.086	22.02%	1.272 *
LOC undrawn balance / assets	1'694	0.019	0.000	0.054	744	0.018	0.000	0.052	22.02%	1.067 *
(LOC limit + cash) / assets	1'694	0.249	0.193	0.208	744	0.293	0.241	0.221	22.02%	0.866 *
(LOC undrawn + cash) / assets	1'694	0.214	0.149	0.214	744	0.269	0.210	0.232	22.02%	0.816 *
<i>II. Client variables</i>										
Assets (Million US \$)	24'733	3'824	566	14'237	9'368	62'360	28'019	115'868	13.62%	0.674
Age (years)	24'733	20.70	16.00	13.13	7'266	31.51	36.00	13.38	8.68%	0.841
Sales growth	24'733	0.001	0.027	0.250	9'368	0.010	0.023	0.202	13.62%	1.015
Total debt / assets	24'733	0.197	0.158	0.206	9'368	0.211	0.197	0.148	13.62%	0.747
No rating (dummy)	24'733	0.665	1.000	0.472	9'368	0.114	0.000	0.318	13.62%	2.652 *
Market share	24'733	0.062	0.007	0.146	9'360	0.227	0.163	0.228	13.60%	0.129
Net profit margin	24'660	0.248	0.368	1.185	9'368	0.286	0.288	1.143	13.66%	1.164
Cash / assets	24'733	0.192	0.111	0.208	9'368	0.113	0.068	0.128	13.62%	1.562
Kaplan Zingales index	21'034	0.865	0.799	0.793	6'074	0.848	0.796	0.509	10.50%	0.880
Whited Wu index	23'530	-0.304	-0.296	0.097	8'711	-0.472	-0.501	0.079	13.53%	0.669
Payout ratio	24'598	0.002	0.000	0.005	9'040	0.004	0.003	0.005	13.02%	0.645 *
Weight (sales to client i / total sales)					9'368	0.161	0.130	0.149		

This table contains summary statistics of key variables in the two samples used in the paper: Compustat firms (Panel A) and supplier-customer relationships (Panel B). All statistics are calculated from July 1, 2005 to June 30, 2008, except for the liquidity variables which are measured exactly once per firm or relationship, at the second quarter of 2006. The last two columns contain (i) the percentage of Compustat firms that are covered in the supplier-customer pairs sample, and (ii) the ratio of the medians [means] of each variable in the Compustat sample to the respective values in the paired sample. The distributions for the customer-supplier sample used in the last two columns are calculated at the firm-quarter level (i.e. each firm-quarter appears only once per supplier or client).

* Mean A / Mean B (instead of medians)

Table 2. Supplier's liquidity and trade credit provision during the crisis.

	<i>Panel A. Cash, Excess Cash, Lines of Credit, Rating and External Finance Dependence</i>				<i>Panel B. Placebo test</i>					
	Cash Reserves	Excess Cash	Liquidity 1 (Cash + LOC Limit)	Liquidity 2 (Cash + Unused LOC)	Cash Reserves, Rated	Cash Reserves, Unrated	Cash Reserves, Low EFD	Cash Reserves, High EFD	Cash Reserves	Liquidity 2 (Cash + Unused LOC)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Crisis	-0.0147*** [0.00395]	-0.00797** [0.00354]	-0.0243*** [0.00483]	-0.0191*** [0.00445]	-0.0230*** [0.00432]	-0.0131** [0.00590]	-0.0148*** [0.00552]	-0.0157*** [0.00536]	-0.0163*** [0.00396]	-0.0234*** [0.00395]
Crisis * Liquidity	0.0240* [0.0130]	0.0211* [0.0124]	0.0461*** [0.0144]	0.0281** [0.0140]	0.130*** [0.0292]	0.0167 [0.0164]	0.0606*** [0.0179]	-0.00370 [0.0177]	-0.0425*** [0.0135]	-0.365 [0.518]
Log of total assets	0.0616*** [0.00697]	0.0421*** [0.00716]	0.0664*** [0.00790]	0.0668*** [0.00790]	0.0678*** [0.00884]	0.0608*** [0.00921]	0.0331*** [0.00965]	0.0794*** [0.00958]	0.0786*** [0.00711]	0.0757*** [0.00879]
Log of age	-0.0429*** [0.0125]	-0.0412*** [0.0133]	-0.0469*** [0.0146]	-0.0455*** [0.0146]	-0.0446*** [0.0130]	-0.0497*** [0.0173]	0.0195 [0.0177]	-0.0563*** [0.0169]	-0.0410*** [0.0106]	-0.0439*** [0.0129]
PPE over assets	-0.185*** [0.0383]	-0.221*** [0.0388]	-0.269*** [0.0424]	-0.266*** [0.0424]	-0.0105 [0.0454]	-0.264*** [0.0523]	0.185*** [0.0650]	-0.319*** [0.0481]	0.1000** [0.0406]	0.113** [0.0481]
Net profit margin	-0.0379*** [0.00241]	-0.0370*** [0.00248]	-0.0275*** [0.00283]	-0.0273*** [0.00283]	-0.0875*** [0.0171]	-0.0373*** [0.00275]	-0.0685*** [0.00509]	-0.0335*** [0.00286]	-0.0710*** [0.00378]	-0.0574*** [0.00519]
Sales growth	-0.174*** [0.00531]	-0.168*** [0.00551]	-0.177*** [0.00607]	-0.177*** [0.00607]	-0.162*** [0.00769]	-0.178*** [0.00676]	-0.173*** [0.00802]	-0.178*** [0.00692]	-0.234*** [0.00573]	-0.201*** [0.00712]
Net worth over assets	-0.128*** [0.0196]	-0.131*** [0.0201]	-0.118*** [0.0224]	-0.119*** [0.0225]	-0.237*** [0.0327]	-0.116*** [0.0242]	0.192*** [0.0287]	-0.280*** [0.0260]	0.00274 [0.0201]	0.0261 [0.0259]
Debt over assets	-0.266*** [0.0264]	-0.219*** [0.0271]	-0.298*** [0.0298]	-0.298*** [0.0298]	-0.235*** [0.0371]	-0.282*** [0.0338]	-0.0537 [0.0373]	-0.345*** [0.0358]	-0.0210 [0.0278]	-0.0429 [0.0344]
Tobin's Q	-0.00797*** [0.00218]	-0.00800*** [0.00220]	-0.00831*** [0.00236]	-0.00855*** [0.00236]	0.00396 [0.00451]	-0.00960*** [0.00261]	-0.00129 [0.00273]	-0.0113*** [0.00318]	0.00424*** [0.00144]	0.00286* [0.00169]
Rating dummies	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.063	0.060	0.064	0.064	0.078	0.062	0.082	0.069	0.086	0.074
Observations	24,733	22,234	19,432	19,432	8,233	16,500	9,563	15,170	26,710	15,007
Number of firms	2,250	1,999	1,694	1,694	739	1,511	876	1,374	3,002	1,589
F statistic					5.957		5.727			
p-value					0.0147		0.0167			

Panel A presents estimates from panel regressions explaining firm-level quarterly trade credit provided for quarters with an end date from July 1, 2005 to June 30, 2008. The dependent variable is accounts receivable over sales. Crisis is an indicator that equals one from the third quarter of 2007 to the second quarter of 2008. The top row indicates the liquidity measure that is interacted with the crisis dummy in each regression: Cash reserves in columns 1 and 5-9; Excess cash in column 2; and total liquidity ratios in columns 3, 4, and 10. Cash reserves is the ratio of cash to total assets. Excess cash is the residual cash to total assets and is defined relative to the model of optimal cash holdings as presented in Dittmar and Mahrt-Smith (2007), estimated over the period 1995-2004. Liquidity 1 is the ratio of cash reserves plus total amount in lines of credit, scaled by assets. Liquidity 2 is the ratio of cash reserves plus unused amount in lines of credit, scaled by assets. Cash reserves, Excess cash and LOCs are measured at the end of the last fiscal quarter ending before July 1, 2006. In columns 5 and 6 the sample is split into mutually exclusive subsamples according to firms' availability of a bond rating, and in columns 7 and 8 the sample is split into mutually exclusive subsamples according to the firms' External Finance Dependence (EFD). EFD is the industry-median proportion of investment not financed by cash flow from operations. The last row of the table provides the F-statistic and the p-value associated to the test of equality of the interaction coefficients of the mutually exclusive subsets. Panel B presents placebo tests using the demand crisis following September 11, 2001. In this case the estimation sample consists of quarterly data from the last quarter of year 2000 and the third quarter of 2002, Cash and LOC variables are measured at the third quarter of year 2000, and Crisis is an indicator that equals to one from the fourth quarter of 2001 to the third quarter of 2002. All specifications control for firms' characteristics which include: size, age, tangibility, net profit margin, sales growth, net worth, total debt, Tobin's Q and dummies for bond ratings. All specifications include firm fixed effects. ***, **, or * indicates significance at the 1%, 5%, or 10% level, respectively.

Table 3. Trade credit provision and supplier's liquidity controlling for client's characteristics.

	No controls	Client controls	Client's EFD	Client Low EFD	Client High EFD	Supplier Low EFD	Supplier High EFD	Client-time FE	Placebo
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Crisis	-0.00605 [0.00697]	-0.0102 [0.00770]	-0.0138* [0.00787]	-0.00338 [0.0107]	-0.0252** [0.0112]	-0.0136 [0.0110]	-0.0112 [0.00987]		-0.0337** [0.0149]
Crisis * Supplier's cash	0.0590** [0.0298]	0.0663** [0.0296]	0.0580** [0.0293]	0.0166 [0.0277]	0.103** [0.0431]	0.0564* [0.0339]	0.0567 [0.0398]	0.133*** [0.0431]	0.0621 [0.0500]
Supplier's log of total assets		-0.0180 [0.0214]	-0.0168 [0.0214]	-0.0277 [0.0266]	-0.0119 [0.0281]	-0.0320 [0.0271]	-0.00859 [0.0282]	-0.0199*** [0.00359]	0.0333 [0.0498]
Supplier's log of age		0.0517*** [0.0162]	0.0476*** [0.0158]	0.0141 [0.0163]	0.244*** [0.0757]	0.242*** [0.0771]	0.0218 [0.0156]	-7.85e-05 [0.00724]	-0.0234 [0.0360]
Supplier's PPE over assets		-0.179 [0.132]	-0.189 [0.134]	-0.193 [0.168]	-0.136 [0.173]	0.0296 [0.158]	-0.309 [0.188]	-0.409*** [0.0315]	0.565*** [0.215]
Supplier's net profit margin		0.00543 [0.0135]	0.00575 [0.0135]	-0.0225* [0.0125]	0.0160 [0.0150]	0.00267 [0.00732]	0.00118 [0.0143]	-0.0196*** [0.00481]	-0.0158 [0.0200]
Supplier's sales growth		-0.0959*** [0.0153]	-0.0913*** [0.0150]	-0.148*** [0.0289]	-0.0734*** [0.0169]	-0.0436*** [0.0208]	-0.138*** [0.0203]	-0.106*** [0.0143]	-0.140*** [0.0204]
Supplier's net worth over assets		0.0739 [0.0558]	0.0670 [0.0564]	-0.0986 [0.0659]	0.230*** [0.0856]	0.265*** [0.0791]	-0.0439 [0.0712]	-0.286*** [0.0232]	0.200** [0.0813]
Supplier's debt over assets		0.0589 [0.0760]	0.0420 [0.0770]	-0.190** [0.0892]	0.237** [0.116]	0.139 [0.103]	-0.0100 [0.0984]	-0.402*** [0.0319]	0.232* [0.119]
Supplier's Tobin's Q		0.00884 [0.00570]	0.00899 [0.00575]	0.00326 [0.00417]	0.0183 [0.0121]	0.00700 [0.00654]	0.0113 [0.00805]	-0.0220*** [0.00351]	-0.00537 [0.00421]
Client's importance		-0.197 [0.121]	-0.0361 [0.0276]	-0.0370 [0.0606]	-0.363* [0.205]	-0.0313 [0.0695]	-0.263 [0.161]	-0.140*** [0.0289]	0.00266 [0.0286]
Client's log of total assets		-0.0292 [0.0274]	0.00536 [0.00940]	-0.0684 [0.0602]	-0.0313 [0.0260]	-0.101 [0.0615]	0.00899 [0.0247]		0.0126 [0.194]
Client's sales growth		0.00565 [0.00943]	0.00838 [0.0464]	0.00773 [0.0180]	0.00476 [0.0106]	0.0105 [0.0162]	-0.00185 [0.0115]		-0.0267** [0.0112]
Client's debt over assets		-0.00533 [0.0474]	-0.0143 [0.0174]	0.0312 [0.0780]	-0.0132 [0.0598]	0.00709 [0.0622]	-0.0309 [0.0669]		-0.0297 [0.0921]
Client's no rating dummy		-0.0124 [0.0175]	0.119 [0.0980]	-0.00775 [0.0258]	-0.0249 [0.0270]	0.0260 [0.0339]	-0.0187 [0.0209]		-0.00443 [0.0390]
Client's market share		0.121 [0.0990]	-0.00863** [0.00412]	0.453*** [0.146]	-0.132 [0.0958]	0.0329 [0.131]	0.148 [0.114]		-0.115 [0.115]
Client's net profit margin		-0.00893** [0.00418]	-0.208* [0.121]	0.0305 [0.0193]	-0.00943*** [0.00357]	-0.0123*** [0.00326]	-0.00820 [0.00554]		0.0121** [0.00526]
Client's cash over assets		-0.108 [0.0948]	-0.104 [0.0956]	-0.0268 [0.0907]	-0.118 [0.152]	-0.00222 [0.116]	-0.128 [0.125]		0.112 [0.138]
Client's EFD * Crisis 2007			0.0514*** [0.0198]						
Supplier rating dummies	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pair fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Client-quarter fixed effects	No	No	No	No	No	No	No	Yes	No
Observations	9,360	9,360	9,252	4,527	4,725	3,161	6,199	9,360	5,920
Number of pairs (client-quarters)	1,341	1,341	1,326	654	672	434	907	(3,363)	1,280
R-squared	0.002	0.038	0.038	0.068	0.051	0.046	0.055	0.135	0.049
F statistic				2.860		0.00273			
p-value				0.0910		0.958			

This table presents estimates from panel regressions explaining firm-level quarterly trade credit provided for quarters with an end date from July 1, 2005 to June 30, 2008 using a sample of firms that report their main customers. Each observation represents a supplier-client relationship. The dependent variable is the supplier's accounts receivable over sales. Suppliers' cash reserves are measured prior to the onset of the crisis and interacted with the crisis dummy in all regressions. In columns 4 and 5 we divide the sample into two mutually exclusive groups according to client's EFD (low/high), and in cols. 6 and 7 the sample is divided into mutually exclusive groups according to supplier's EFD (low/high). In col. 9 the crisis refers to the 2001 demand crisis following the events in 9/11 (as defined in Table 2). All specifications except for the first control for suppliers' characteristics (defined in Table 2). Cols. 2-7 and 9 also control for client's characteristics which include: size, sales growth, total debt and a dummy for not having a long term debt rating. Specifications 1-7 and 9 include pairs fixed effects, while specification 8 contains client-quarter fixed effects and supplier cash to assets ratio. ***, **, or * indicates that the coefficient is significant at the 1%, 5%, or 10% level, respectively. Standard errors are clustered at the pair level.

Table 4. Suppliers' liquidity, clients' liquidity, and trade credit provision during the crisis.*Panel A. Supplier-Customer pairs fixed effects*

	Cash Reserves	Excess Cash	Liquidity 1 (Cash+LOC limit)	Liquidity 2 (Cash + Unused LOC)	Liquidity 2 (Cash + Unused LOC)
	(1)	(2)	(3)	(4)	(5)
Crisis	-0.0138* [0.00787]	-0.0127** [0.00616]	-0.0220** [0.0101]	-0.0165* [0.00885]	-0.0175 [0.0115]
Crisis * Supplier liquidity	0.0580** [0.0293]	0.0625** [0.0288]	0.0885** [0.0373]	0.0735** [0.0346]	0.0741* [0.0448]
Client liquidity	-0.104 [0.0956]	-0.146* [0.0794]	-0.100 [0.119]	-0.0992 [0.119]	-0.00204*** [0.000721]
Measure of client liquidity	Cash	Cash	Cash	Cash	Liquidity 2
Supplier controls	Yes	Yes	Yes	Yes	Yes
Client controls	Yes	Yes	Yes	Yes	Yes
Pair fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.038	0.042	0.052	0.051	0.057
Observations	9,252	8,444	7,069	7,069	5,169
Number of pairs	1,326	1,199	987	987	677

Panel B. Client-quarter fixed effects

	Cash Reserves	Excess Cash	Liquidity 1 (Cash+LOC limit)	Liquidity 2 (Cash + Unused LOC)
	(6)	(7)	(8)	(9)
Supplier liquidity	-0.212*** [0.0296]	-0.263*** [0.0297]	-0.0793** [0.0354]	-0.123*** [0.0360]
Crisis * Supplier liquidity	0.133*** [0.0431]	0.159*** [0.0535]	0.108* [0.0625]	0.132** [0.0605]
Supplier controls	Yes	Yes	Yes	Yes
Client controls	No	No	No	No
Client-quarter fixed effects	Yes	Yes	Yes	Yes
R-squared	0.135	0.135	0.172	0.173
Observations	9,360	8,695	7,315	7,315
Number of client-quarters	3,363	3,342	2,985	2,985

This table presents estimates from panel regressions explaining firm-level quarterly trade credit provided for quarters with an end date from July 1, 2005 to June 30, 2008 using a sample of firms that report their main customers. Each observation represents a supplier-client relationship. The dependent variable is the supplier's accounts receivable over sales. Suppliers' liquidity variables are: cash in column 1, excess cash in column 2, cash + LOC limit in col. 3 and cash + unused LOC balances in Columns 4 and 5. Liquidity is measured prior to the onset of the crisis and interacted with the crisis dummy in all regressions. Specifications in Panel A contain suppliers' characteristics (as defined in table 2) and client's characteristics which include: size, sales growth, total debt, a dummy for not having a long term debt rating, client EFD, and client liquidity. Client liquidity is measured as cash in col. 1-4 and as cash + unused LOC balances in column 4. Specifications in Panel B contain client-quarter fixed effects and supplier controls. ***, **, or * indicates that the coefficient is significant at the 1%, 5%, or 10% level, respectively. Standard errors are clustered at the pair level.

Table 5. Supplier's leverage and trade credit provision during the crisis.

	Short Term Debt	Long Term Debt	Total Debt	Net Short Term Debt
	(1)	(2)	(3)	(4)
Crisis	0.0126** [0.00630]	0.00817 [0.00759]	0.0131 [0.00805]	-0.00558 [0.00665]
Crisis * Leverage measure	-0.151* [0.0894]	-0.00805 [0.0390]	-0.0268 [0.0352]	-0.0633** [0.0270]
Firm (supplier) controls	Yes	Yes	Yes	Yes
Client controls	Yes	Yes	Yes	Yes
Pair fixed effects	Yes	Yes	Yes	Yes
Observations	9,292	9,325	9,274	9,292
R-squared	0.038	0.036	0.037	0.038
Number of pairs	1,320	1,332	1,316	1,320

This table presents estimates from panel regressions explaining firm-level quarterly trade credit provided for quarters with an end date from July 1, 2005 to June 30, 2008 using a sample of firms that report their main customers. Each observation represents a supplier-client relationship. The dependent variable is the supplier's accounts receivable over sales. Suppliers' leverage variables are measured prior to the onset of the crisis and interacted with the crisis dummy in all regressions (as liquidity variables in Table 2). Leverage variables are: short term debt to assets in column 1, long term debt to assets in column 2, total debt to assets in col. 3 and net short term debt (short term debt net of cash) to assets in column 4. All specifications contain suppliers' characteristics (as defined in table 2), client characteristics (as in Table 4) and pair fixed effects. ***, **, or * indicates that the coefficient is significant at the 1%, 5%, or 10% level, respectively. Standard errors are clustered at the pair level.

Table 6. Client's debt in trade credit and supplier's liquidity.

	None	Supplier's Cash	Supplier's Excess Cash	Supplier's LOC dummy	Liquidity 1 (Cash + LOC Limit)	Liquidity 2 (Cash + Unused)
	(1)	(2)	(3)	(4)	(5)	(6)
Crisis	-0.0268*** [0.00527]	-0.0336*** [0.00548]	-0.0202*** [0.00625]	-0.0339*** [0.00544]	-0.0375*** [0.00684]	-0.0373*** [0.00691]
Crisis * Supplier's liquidity		0.140** [0.0601]	0.0706** [0.0320]	0.0479** [0.0193]	0.0964*** [0.0355]	0.0955** [0.0376]
Client's log of total assets	-0.131*** [0.0279]	-0.135*** [0.0280]	-0.138*** [0.0287]	-0.134*** [0.0289]	-0.133*** [0.0289]	-0.133*** [0.0289]
Client's log of age	0.0375*** [0.0110]	0.0312*** [0.0107]	0.0349*** [0.0105]	0.0438*** [0.0121]	0.0362*** [0.0112]	0.0363*** [0.0112]
Client's current assets	-0.491*** [0.0736]	-0.444*** [0.0670]	-0.444*** [0.0694]	-0.428*** [0.0686]	-0.423*** [0.0691]	-0.424*** [0.0692]
Client's sales growth	-0.210*** [0.0288]	-0.185*** [0.0198]	-0.187*** [0.0205]	-0.193*** [0.0210]	-0.192*** [0.0210]	-0.192*** [0.0210]
Client's debt over assets	-0.150 [0.0921]	-0.179** [0.0878]	-0.190** [0.0927]	-0.221** [0.0937]	-0.221** [0.0942]	-0.219** [0.0942]
Client's cash over assets	-0.579*** [0.0651]	-0.550*** [0.0648]	-0.573*** [0.0675]	-0.583*** [0.0685]	-0.553*** [0.0693]	-0.553*** [0.0696]
Supplier's log of assets	0.0249** [0.0120]	0.0163 [0.0108]	0.0185* [0.0109]	0.0183* [0.0108]	0.0181* [0.0109]	0.0182* [0.0109]
Supplier's sales growth	0.000302 [0.000838]	0.000570 [0.000782]	0.000498 [0.000765]	0.000290 [0.000715]	0.000325 [0.000720]	0.000326 [0.000720]
Supplier's debt over assets	0.0637** [0.0300]	0.0697** [0.0323]	0.0676** [0.0337]	0.0818** [0.0342]	0.0812** [0.0343]	0.0812** [0.0343]
Supplier's net profit margin	0.000584 [0.00276]	-0.00103 [0.00208]	-0.000963 [0.00214]	-0.00143 [0.00216]	-0.00150 [0.00215]	-0.00150 [0.00215]
Supplier's weight	0.985*** [0.341]	0.904*** [0.328]	0.922*** [0.333]	0.837** [0.367]	0.842** [0.369]	0.843** [0.369]
Pair fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.063	0.056	0.057	0.053	0.053	0.053
Observations	14,815	14,331	13,853	13,670	13,670	13,670
Number of pairs	2,407	2,222	2,121	2,097	2,097	2,097

This table presents estimates from panel regressions explaining firm-level quarterly debt in trade credit for quarters with an end date from July 1, 2005 to June 30, 2008. Each observation represents a supplier-client relationship. The dependent variable is the client's accounts payable over cost of goods sold. All specifications include client and supplier controls. Client controls include: size (measured in assets), age, current assets to assets ratio, sales growth, total debt over assets, and cash over assets. Suppliers' characteristics include size, sales growth, total debt over assets, and net profit margin. All but the first specification also include the interaction of supplier's liquidity (measured one year previous to the start of the crisis) with the crisis dummy, as in Tables 2-6. Liquidity is measured as cash reserves in col. 2, excess cash in col 3, LOC dummy in col 4, cash plus LOC limit in col. 5, and cash plus undrawn LOC balances in col 6. Supplier's weight is the ratio of purchases from the given supplier to total cost of goods sold. All specification include relationship fixed effects and a constant. ***, **, or * indicates that the coefficient is significant at the 1%, 5%, or 10% level, respectively. Standard errors are clustered at the pair level.

Table 7. Credit constraints and debt in trade credit.

Panel A. Debt in trade credit, client constraints, and supplier's cash

	Kaplan Zingales	Whited Wu	Payout Ratio	No Rating Dummy	LOC Limit	Unused LOC	External Finance Dependence
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Crisis	-0.0385*** [0.0127]	0.216*** [0.0332]	-0.0176*** [0.00671]	-0.0362*** [0.00547]	-0.0329*** [0.00563]	-0.0244*** [0.00509]	-0.0627*** [0.00753]
Crisis * Client's constraints	0.00610 [0.0134]	0.517*** [0.0697]	-0.171*** [0.0568]	0.0404*** [0.0150]	-0.248** [0.118]	-0.928*** [0.197]	0.282*** [0.0349]
Crisis * Supplier's cash	0.140* [0.0751]	0.0238 [0.0638]	0.121** [0.0594]	0.115* [0.0649]	0.164** [0.0696]	0.164** [0.0698]	0.0908 [0.0593]
Firm (client) controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Supplier controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pair fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.064	0.061	0.057	0.056	0.059	0.064	0.064
Observations	8,998	14,047	14,212	14,331	12,527	12,527	14,331
Number of pairs	1,412	2,163	2,202	2,222	1,954	1,954	2,222

Panel B. Debt in trade credit and credit constraints, controlling for time varying unobservable supplier characteristics

	Kaplan Zingales	Whited Wu	Payout Ratio	No Rating Dummy	LOC Limit	Unused LOC	External Finance Dependence
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Client's constraints	-0.0868** [0.0401]	0.00480 [0.279]	0.535*** [0.0977]	-0.0957*** [0.0344]	0.904*** [0.169]	2.390*** [0.251]	0.579*** [0.0822]
Crisis * Constraint	0.0385 [0.0545]	0.719*** [0.268]	-0.453*** [0.172]	0.0865 [0.0683]	-0.315 [0.248]	-1.198*** [0.334]	0.271** [0.127]
Firm (client) controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Supplier-quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.273	0.178	0.176	0.156	0.215	0.231	0.187
Observations	10,510	16,192	16,394	16,553	14,514	14,514	14,815
Number of supplier-quarters	7,727	10,396	10,451	10,523	9,720	9,720	9,704

This table presents estimates from panel regressions explaining firm-level quarterly debt in trade credit for quarters with an end date from July 1, 2005 to June 30, 2008. Each observation represents a supplier-client relationship. The dependent variable is the client's accounts payable over cost of goods sold. All specifications include client controls which include: size (measured in assets), age, current assets to assets ratio, sales growth, total debt over assets, cash over assets, and the importance of the supplier to the given client, measured as purchases from that supplier over total cost of goods sold. Specifications in Panel A also include suppliers' controls which include size, sales growth, total debt over assets, and net profit margin, and the interaction of supplier's cash reserves (measured one year previous to the start of the crisis) with the crisis dummy, as in Tables 2-6. Specifications in Panel A include relationship fixed effects and a constant. Specifications in Panel B control for supplier-quarter fixed effects. ***, **, or * indicates that the coefficient is significant at the 1%, 5%, or 10% level, respectively. Standard errors are clustered at the pair level.

Table 8. Supplier's cash and liquidity provision over the crisis episode.*Panel A. Whole sample**Panel B. Supplier - customer sample*

	Cash Reserves	Excess Cash	Liquidity 2	Cash Reserves	Excess Cash	Liquidity 2
	(1)	(2)	(3)	(4)	(5)	(6)
Crisis 2007	-0.0147*** [0.00410]	-0.00840** [0.00362]	-0.0193*** [0.00462]	-0.0119 [0.00829]	-0.00679 [0.00669]	-0.0175* [0.00974]
Crisis 2008	-0.0310*** [0.00436]	-0.0272*** [0.00393]	-0.0337*** [0.00481]	-0.0233*** [0.00890]	-0.0171** [0.00764]	-0.0225** [0.0103]
Post-crisis	-0.0140*** [0.00471]	-0.0163*** [0.00430]	-0.0158*** [0.00514]	-0.00417 [0.0143]	-0.00364 [0.0134]	-0.00655 [0.0157]
Crisis 2007 * Liquidity	0.0232* [0.0139]	0.0243* [0.0133]	0.0309** [0.0150]	0.0915*** [0.0353]	0.0992*** [0.0346]	0.108*** [0.0412]
Crisis 2008 * Liquidity	-0.00501 [0.0148]	-0.0129 [0.0142]	0.00617 [0.0155]	0.108*** [0.0395]	0.105*** [0.0380]	0.110** [0.0451]
Post-crisis * Liquidity	-0.0593*** [0.0155]	-0.0334** [0.0148]	-0.0456*** [0.0160]	-0.00237 [0.0540]	-0.0202 [0.0548]	-0.00658 [0.0546]
Supplier controls	Yes	Yes	Yes	Yes	Yes	Yes
Client controls	No	No	No	Yes	Yes	Yes
Supplier fixed effects	Yes	Yes	Yes	No	No	No
Pair fixed effects	No	No	No	Yes	Yes	Yes
R-squared	0.060	0.060	0.058	0.033	0.035	0.042
Observations	38,236	34,325	31,375	11,566	10,614	9,188
Number of firms (pairs)	2,249	1,998	1,693	(1,046)	(964)	(769)

This table presents estimates from panel regressions explaining firm-level quarterly trade credit provided for quarters with an end date from July 1, 2005 to June 30, 2010. The dependent variable is accounts receivable over sales. Panel A specifications are estimated using Compustat firms and include supplier fixed effects; Panel B specifications are estimated using relationship data and include relationship fixed effects. The top row indicates the liquidity measure that is interacted with the crisis dummies in each regression: Cash Reserves in columns 1 and 4, Excess Cash in columns 2 and 5, and Cash + Unused balance in LOC in columns 3 and 6. Cash and LOC variables are measured at the second quarter of year 2006. Crisis 2007 is an indicator that equals to one from the third quarter of 2007 to the second quarter of 2008. Crisis 2008 is an indicator that equals to one from the third quarter of 2008 to the second quarter of 2009. Post-crisis is an indicator that equals to one from the third quarter of 2009 to the second quarter of 2010. All other variables are defined in tables 2 and 4. All specifications control for suppliers' characteristics (as in Table 2). Panel B specifications also control for client characteristics (as in Table 4). All specifications include firm fixed effects. ***, **, or * indicates that the coefficient is significant at the 1%, 5%, or 10% level, respectively.

Table 9. Liquidity provision and firm performance

Panel A. Supplier performance

	Return on assets			Return on sales			EBITDA			Net profit margin		
	2008.q2	2009.q2	2010.q2	2008.q2	2009.q2	2010.q2	2008.q2	2009.q2	2010.q2	2008.q2	2009.q2	2010.q2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Crisis	-0.00445***	-0.00891***	-0.00837***	-0.0456**	-0.0511***	-0.0653***	-0.00445***	-0.00661***	-0.00874***	-0.0606***	-0.0542***	-0.0729***
	[0.000707]	[0.000747]	[0.000745]	[0.0209]	[0.0172]	[0.0176]	[0.00122]	[0.00139]	[0.00180]	[0.0167]	[0.0148]	[0.0162]
Predicted (Crisis * Δ AR/S))	0.0174	0.0278*	0.0364**	1.473***	0.732**	1.103***	0.0926***	0.145***	0.204***	1.831***	1.841***	2.233***
	[0.0128]	[0.0147]	[0.0151]	[0.377]	[0.339]	[0.355]	[0.0321]	[0.0393]	[0.0486]	[0.302]	[0.291]	[0.326]
Supplier controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	25,437	32,655	36,149	25,437	32,655	36,149	24,404	31,446	37,458	25,358	32,562	38,702
Number of firms	2,047	2,047	2,047	2,047	2,047	2,047	2,033	2,037	2,040	2,047	2,047	2,047
Cragg-Donald Wald F	73.13	82.77	83.04	73.13	82.77	83.04	14.89	19.06	21.30	71.76	81.87	81.95

Panel B. Client performance

	Return on assets			Return on sales			EBITDA			Net profit margin		
	2008.q2	2009.q2	2010.q2	2008.q2	2009.q2	2010.q2	2008.q2	2009.q2	2010.q2	2008.q2	2009.q2	2010.q2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Crisis	-0.00169	-0.00503***	-0.00462***	-0.0101	-0.0205**	-0.0156	-0.000536	-0.00140*	-0.00198***	-0.00500**	-0.00355	-0.00331
	[0.00112]	[0.00124]	[0.00116]	[0.00737]	[0.0104]	[0.0121]	[0.000624]	[0.000719]	[0.000645]	[0.00205]	[0.00906]	[0.00740]
Crisis * Δ Supplier AR/S	0.0117***	0.0103***	0.00991***	0.0667***	0.0542**	0.0557*	0.00132	0.00367**	0.00428***	-0.000511	0.00993	0.00621
	[0.00282]	[0.00302]	[0.00283]	[0.0186]	[0.0252]	[0.0294]	[0.00156]	[0.00173]	[0.00156]	[0.00516]	[0.0220]	[0.0181]
Client controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Supplier controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,139	2,898	3,283	2,139	2,898	3,283	2,091	2,838	3,607	2,138	2,897	3,674
Number of firms	197	210	210	197	210	210	196	210	223	197	210	223

This table presents estimates from panel regressions explaining firm-level quarterly performance measures. Dependent variables are: return on assets (col 1-3), return on sales (col 4-6), earnings before interest, taxes and depreciation (col 7-9), and net profit margin (col 10-12). For each performance measure, we run the estimations over three different time frames (i) the 2007-2008 crisis, (ii) the complete 2007-2009 crisis episode, and (iii) from the start of the credit crunch (2007q3) to one year after the crisis (2010q2). Crisis is an indicator that equals to one from the third quarter of 2007 to the second quarter of 2008 (columns 1, 4, 7 and 10). Crisis is an indicator that equals to one from the third quarter of 2007 to the second quarter of 2009 (columns 2, 5, 8 and 11). Crisis is an indicator that equals to one from the third quarter of 2007 to the second quarter of 2010 (columns 3, 6, 9 and 12). Δ AR/S is the change of the average accounts receivable to sales ratio in quarters 2006:3-2007:2 relative to the average ratio during 2007:3-2008:2. In Panel A, we instrument Δ AR/S with supplier's pre-crisis cash stocks. All specifications control for firms' characteristics which include: size, age, tangibility, sales growth, net worth, Tobin's Q, total debt, and ratings dummies. All specifications include firm fixed effects and a constant. ***, **, or * indicates that the coefficient is significant at the 1%, 5%, or 10% level, respectively.

Table A.1 Robustness checks on sample, cash measurement, and dependent variable denominator.

	Sample: 2005.3 to 2008.2		Sample: 2004.3 to 2008.2			Sample: 2005.3 to 2008.2			Sample: 2006.3 to 2008.2		
	Non-cash assets	Non-receivables assets		Sales		Sales		Sales			
	2006 Q2 (1)	2006 Q2 (2)	2006 Q2 (3)	2005 Q2 (4)	2004 Q2 (5)	2006 Q2 (6)	2005 Q2 (7)	2004 Q2 (8)	2006 Q2 (9)	2005 Q2 (10)	2004 Q2 (11)
<i>Panel A. Whole Sample Estimations</i>											
Crisis 2007	-0.0163*** [0.00332]	-0.0154*** [0.00402]	-0.0160*** [0.00387]	-0.0159*** [0.00392]	-0.0145*** [0.00387]	-0.0147*** [0.00395]	-0.0114*** [0.00398]	-0.0117*** [0.00392]	-0.0162*** [0.00411]	-0.0143*** [0.00418]	-0.0161*** [0.00411]
Crisis 2007 * Cash	0.0123*** [0.00274]	0.0219* [0.0117]	0.0304** [0.0127]	0.0273** [0.0129]	0.0177 [0.0125]	0.0240* [0.0130]	0.00456 [0.0131]	0.00526 [0.0126]	0.0283** [0.0136]	0.0104 [0.0139]	0.0222* [0.0133]
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.068	0.056	0.062	0.060	0.062	0.063	0.059	0.063	0.061	0.056	0.061
Observations	24,739	24,707	33,264	34,346	34,462	24,733	24,991	24,801	16,093	15,972	15,875
Number of Firms	2,250	2,245	2,256	2,455	2,608	2,250	2,443	2,423	2,242	2,231	2,219
<i>Panel B. Paired Sample Estimations</i>											
Crisis 2007	-0.00551 [0.00754]	-0.00643 [0.00751]	-0.00968 [0.00791]	-0.0141* [0.00745]	-0.00950 [0.00711]	-0.0102 [0.00770]	-0.00934 [0.00768]	-0.00508 [0.00735]	-0.0108 [0.00714]	-0.0120* [0.00724]	-0.00750 [0.00684]
Crisis 2007 * Cash	0.0178* [0.0108]	0.0435* [0.0252]	0.0490 [0.0301]	0.0572** [0.0261]	0.0367 [0.0238]	0.0663** [0.0296]	0.0581** [0.0276]	0.0351 [0.0251]	0.0509* [0.0282]	0.0554** [0.0261]	0.0310 [0.0235]
Pairs fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.039	0.037	0.033	0.033	0.033	0.038	0.037	0.038	0.047	0.044	0.043
Observations	9,360	9,356	12,458	12,944	12,981	9,360	9,483	9,424	6,236	6,184	6,155
Number of pairs	1,341	1,339	1,545	1,656	1,706	1,341	1,430	1,418	1,186	1,179	1,172

This table presents several specifications for validation purposes. The dependent variable is accounts receivable over sales. The sample consists of quarterly data; we use the sample of suppliers in Panel A and the sample of suppliers matched with their customers (pairs) in Panel B. Crisis 2007 is an indicator that equals to one from the third quarter of 2007 to the second quarter of 2008. Crisis 2007 * Cash refers to the interaction of the crisis indicator with firm's cash. All specifications control for firms' characteristics which include: size, age, tangibility, net profit margin, sales growth, net worth, Tobin's Q, total debt, and rating dummies; additionally, in Panel B we include client characteristics as in Table 4. Tangibility, net profit margin, net worth, and total debt are scaled by non-cash assets in column 1; by assets net of accounts receivables in column 2; and by total assets in columns 3-11. The starting points of the sample are quarters starting on: July 1, 2005 for columns 1, 2, and 6-8; July 1, 2004 for columns 3-5 and July 1, 2006 for columns 9-11. In all columns, the ending points of the sample period is the quarter ending on June 30, 2008. Cash is measured at the end of the last fiscal quarter ending before July 1 of: year 2006 in columns 1,2,3, 6 and 9; year 2005 in columns 4, 7 and 10; and year 2004 in columns 5, 8 and 11. All specifications in Panel A include firm fixed effects, while in Panel B they include pair fixed effects. ***, **, or * indicates that the coefficient is significant at the 1%, 5%, or 10% level, respectively.