Trade credit: Elusive insurance of firm growth

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ABSTRACT

Firms depend heavily on trade credit. This paper findss that the resulting trade credit linkages are an elusive insurance: as long as a firm is financially unconstrained and times are good, more trade credit enhances sales stability and insures against shocks to firm's suppliers. However, if a firm becomes financially constrained, runs short of liquid assets or when times are bad, trade credit's stabilizing abilities come to an end and trade credit itself can serve as mechanism propagating supplier shocks downstream.

I Introduction

The literature on trade credit holds different views regarding its role in mitigating or aggravating shocks. Burkart and Ellingsen (2004) and Cuñat (2007) argue that trade credit provides insurance against shocks, by transfering part of the risk borne by a customer onto the supplier. Jacobson and von Schedvin (2015) and Jorion and Zhang (2009) focus on the negative aspects of trade credit, including contagion and counterparty risk. This paper reconciles both views and finds that trade credit is an elusive insurance: as long as a firm

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is financially unconstrained, more trade credit enhances sales stability and insures against shocks from a firm's suppliers. As soon as a firm becomes financially constrained, trade credit's stabilizing abilities come to an end and trade credit itself can serve as a mechanism propagating supplier shocks downstream.

The importance of trade credit is indisputable. As recounted in Barrot (2015) and reported by The Financial Times, about 90% of global merchandise is purchased on trade credit.[1] Many of the goods sold on trade credit are likely not to be a homogenous or standardized (Giannetti, Burkart, and Ellingsen (2011)) making them difficult to sell to some other firm if required (Burkart and Ellingsen (2004)). According to Cuñat (2007), trade credit is typically the result of a switching cost associated with losing the production partner. Giannetti, Burkart, and Ellingsen (2011) elaborates further and proposes that trade credit accompanies sales of differentiated goods or services. Summing up, trade credit increases the switching cost either through the customized nature of goods that can only be resold on the market at a discount or through the contractual agreement between customer and supplier. This in turn makes firms less flexible in changing their production partners and strengthens the customer-supplier relationship. In this view, if a supplier receives a negative productivity shock then it prefers to first deliver the goods to the customer with which it has a more significant trade credit relationship.

To illustrate the insuring properties of trade credit, imagine an example illustrated in Figure 1. In March 2002 ON Semiconductor, a semiconductors supplier company, relocated its wafer fabrication from factories in mainland Europe and the UK to a factory in Japan. That year it experienced a lower sales growth than other firms in the industry.[2] At that time its customers - Avnet and Motorola - suffered drops in their sales, with Motorola buying more on trade credit and being considerably less affected by the negative productivity shock at ON Semiconductor.

The opposite may occur in the presence of a positive shock, when the trade credit contrac-

[1]"World Bank urged to lift trade credit finance," *The Financial Times*, November 11, 2008.

[2]Throughout this paper we will consider a negative shock to occur if a firm's growth rate falls below the growth rate of the economy (or industry, or region). Then, a firm's growth rate in excess of the economy (or industry, or region) growth rate is a positive shock to the firm.

tual agreement may prevent customers from reaping all the benefits of new developments. For example, Ed Zander, the former CEO of Motorola was quoted saying that during the smartphone revolution his company missed a year of opportunities due to a contractual agreement with an ill-chosen supplier (Chicago Magazine, 2014). As shown in Figure 1 Panel (b), in 2004 Motorola still purchased more inputs on trade credit than another customer of ON Semiconductor. But following a positive shock to the supplier, this time Motorola grew at a lower rate. In both cases a more extensive use of trade credit by Motorola reduced its exposure to the shock (whether negative or positive) at ON Semiconductor.

With this paper, we contribute to our understanding of the impact of trade credit in three ways. First, we introduce a model of a multi-sector economy in which we reconcile the trade credit literature with the literature on production networks and highlight the role of both trade credit and production linkages in propagating firm-level shocks throughout the economy. We investigate a mechanism described by Long and Plosser (1983) and Acemoglu et al. (2012), in which a business cycle arises as a result of asymmetric production linkages.

Acemoglu et al. (2012) emphasize that in an economy with asymmetric production linkages, in which one industry plays an important role as a supplier to other industry production process, the diversification argument of Lucas (1977) does not apply. In other words, idiosyncratic shocks do not average out in the aggregate but instead cause economic activity to move together across sectors. Horvath (2000) and Holly and Petrella (2012) present evidence that a supplier-customer network propagates sectoral or aggregate shocks through the economy. In spite of the wealth of research on cross-sector co-movements, there is little empirical evidence at the firm level, on the role of production and trade credit linkages between individual firms. We therefore borrow from Raddatz (2010) and Balke (2000) and augment those studies with the trade credit dimension. This study aims to bridge this gap by demonstrating the presence and importance of production and trade credit networks in the propagation of idiosyncratic shocks on a granular (firm) level.

Our second contribution concerns a more thorough understanding of the dark side of credit linkages and in particular of trade credit linkages. For example, Kiyotaki and Moore

(1997, 2002) postulate that trade credit linkages between financially constrained firms can stimulate co-movements between production partners, in particular during a recession. Jorion and Zhang (2009) continue this string of thought and show that a bankruptcy announcement of one firm is followed by a negative stock price reaction among its creditors. Creditors of a distressed firm also experience higher CDS spreads and are more prone to bankruptcy in the near future. Similarly, Jacobson and von Schedvin (2015) find evidence that creditors suffer higher default risk following their partners' default on their trade credit claims. We show that in general trade credit offers an insurance against shocks experienced by a production partner. However, for financially constrained firms, trade credit has no more stabilizing abilities and can serve as a mechanism propagating supplier shocks onto customers.

Lastly, our paper contributes by empirically testing the model of Acemoglu et al. (2012), augmented with a trade credit relationship. Although firm-level shocks take an important place in the economic debate, to the best of our knowledge there is no evidence on their role in conjunction with production linkages and trade credit in creating firm co-movements.[3]

Our results draw a rather gloomy picture of the role of trade credit. On the one hand, if a customer uses trade credit from its supplier, a positive shock to this supplier means that this customer grows at a 20-25% rate than it would have grown had it not received any trade credit. On the other hand, when a supplier is hit by a negative shock, trade credit process to be an elusive insurance and fails to provide protection for financially constrained firms.

To further corroborate these empirical results, we delve into two key aspects of the propagation mechanism that we investigate. First, we disentangle the effect of common shocks from the effect of production and trade credit linkages by analyzing firms that operate in the same region or the same industry. This allows us to more cleanly identify the relationship between trade credit and sales we are interested in, by exploiting the cross-sectional variation at the industry or regional level. Second, we distinguish between upstream propagation and downstream propagation of shocks by exploiting differences in the extent to which a

[3]There is some evidence regarding effect, through the impact on the market value of firms' equity. Cohen and Frazzini (2008) show that stock prices of production partners follow the same pattern. Hertzel et al. (2008) observe a negative stock price reaction after a bankruptcy of a production partner.

customer has many heavily reliant suppliers. In theory, with upstream propagation of a shock, if the important customer grows at a high rate, its suppliers are expected to have a positive boost in their sales and are likely grow at a rate higher than the rest of the economy, possibly confounding the downstream propagation we are interested. However, we find no evidence of this reverse causality.

The remainder of this paper continues as follows. In Section II, we introduce trade credit linkages into the model of Acemoglu et al. (2012). Section III describes our empirical approach, and in Section IV we detail our data. Section V contains our empirical analysis, before we conclude in Section VI.

II Theory

In this section we introduce a structural model with explicit production and trade credit linkages. We consider a static version of the multi-sector economy of Long and Plosser (1983), where the economy is populated by a representative household with given tastes and production possibilities. We assume the household has a Cobb-Douglas utility function over n distinct commodities produced by n distinct firms:

$$u(c_1, c_2, \ldots, c_n) = \prod_{i=1}^{n} (c_i)^{1/n}, \tag{1}$$

where c_n is the consumption of firms i's commodity. The household is endowed with one unit of labor, which is supplied inelastically. At the beginning of each period, the household decides about its consumption as well as commodity and labor inputs to various production transformations to be completed in this period. Those choices are constrained by the availability of labor and inputs. As we assume the commodities to be perishable, only the amount produced in a given period can be used as an input in the production process in that particular period.

During the period, the production transformation is subject to various exogenous shocks, which alter the production possibilities and ultimately determine the amount of commodities available for consumption or production input. These shocks affect the household either through the product chain or through the trade credit chain. Each commodity is produced by a competitive firm and can either be directly consumed or used as an input in the production of another commodity. Following Raddatz (2010), we allow a firm i to buy a fraction β_i of its input on trade credit. This is where we extend the model specification of Acemoglu et al. (2012). In particular, a fraction $(1-\beta_i)$ is paid up-front or on delivery while payment of the fraction β_i is due at a later date and shows up in the customer's balance sheet as an account payable.

In particular, n firms buy intermediary inputs from one another and firm i produces quantity x_i of commodity i according to a Cobb-Douglas technology with constant returns to scale:

$$\begin{aligned} x_i &= z_i^{\alpha} l_i^{\alpha} \prod_{j=1}^{n} x_{ij}^{(1-\alpha)(1-\beta_i)w_{ij}} x_{ij}^{(1-\alpha)(1-\eta)\beta_i w_{ij}} \\ &= z_i^{\alpha} l_i^{\alpha} \prod_{j=1}^{n} x_{ij}^{(1+\eta\beta_i)(1-\alpha)w_{ij}} \end{aligned} \tag{2}$$

where $z_i = exp(\xi_i)$ is firm i's specific productivity shock distributed independently across firms, l_i is the amount of labor hired by firm i, x_{ij} is the amount of commodity j used in the production process of commodity i, parameter α is the output elasticity of labor in the economy and parameter η governs the effect of trade credit.

If η assumes a value greater than zero, the inputs purchased on trade credit have greater output elasticity than the inputs purchased directly. In the reverse situation, if η assumes a value less than zero, the inputs purchased directly have greater productivity. The parameter $w_{ij} \geq 0$ denotes an element in the $(n \times n)$input-output matrix W that measures the amount spent on input j per dollar of production of firm i.

The column sums of W imply the importance of a firm as a supplier to other firms' production processes. At the firm level, the diagonal of W is equal to zeroes since a firm does not deliver to itself. The fact that a firm uses intermediate inputs from other firms is a basis for interconnectedness in this economy. We assume that the transmission of idiosyncratic shocks occurs downstream through the input-output matrix from supplier to customers only, and exclude the possibility of upstream shock transmission.

Let y denote the logarithm of real value added, also referred to as *aggregate output*. In Appendix A we show that the evolution of aggregate output follows:

$$y = \mu + u'\xi \tag{3}$$

where μ is a constant that depends on model parameters only, ξ is a $(n \times 1)$ vector of firm specific shocks and u is a $(n \times 1)$ vector that governs the transmission of idiosyncratic shocks in the economy. Equation (3) shows how fluctuations in aggregate output originate from disturbances to a firm's production possibilities. Those disturbances are weighted by the importance of production and trade credit linkages, reflected by the vector u. It holds that:

$$u = \frac{\alpha}{n} \left[I - (1-\alpha)(1+\eta B) W' \right]^{-1} \mathbf{1} \tag{4}$$

where $B = diag(\beta_1, \ldots, \beta_n)$ and $\mathbf{1}$ is a $(n \times 1)$ vector of ones. Similarly as in Raddatz (2010), the vector u reflects the impact of both the production network, through the input-output matrix W, and the trade credit channel, through B, in transmitting the idiosyncratic shocks. In particular, the parameter η is a measure for the importance of the trade credit linkage. If η assumes a value greater than zero it amplifies the transmission mechanism that occurs due to the direct production process linkage. Values lower than zero decrease this transmission mechanism. If trade credit has no effect on the transmission of idiosyncratic shocks between firms, the parameter η assumes a value of zero and the above equation simplifies to the influence vector of Acemoglu et al. (2012) given by:

$$v = \frac{\alpha}{n} \left[I - (1-\alpha) W' \right]^{-1} \mathbf{1}, \tag{5}$$

In the latter case, fluctuations in aggregate output as a result of idiosyncratic shocks at the firm level only transmit through the production network in the economy.

We further disentangle the transmission effects by taking a first order Taylor approximation of u around $\eta = 0$. It follows that:

$$
\begin{aligned}
u \approx & \frac{\alpha}{n} \left[I - (1-\alpha) W' \right]^{-1} \mathbf{1} + \eta \frac{\alpha}{n} \left[I - (1-\alpha) W' \right]^{-1} (1-\alpha) B W' \left[I - (1-\alpha) W' \right]^{-1} \mathbf{1} \\
= & v + \eta \left[I - (1-\alpha) W' \right]^{-1} (1-\alpha) B W' v.
\end{aligned} \tag{6}
$$

The first term in equation (6) represents the direct production network linkages, and the second term shows the effect of the trade credit channel. In particular, in case of negative values for η, the larger the share of inputs provided on trade credit (B), the smaller the transmission of a potential input shock. In that case, trade credit acts as insurance against supplier shocks. Positive values of η give greater weight to supplier shocks, and therefore magnify supplier-level shocks felt by its customers.

For a single firm i, equations (3) and (6) imply the following relationship to input shocks:

$$
y_i = \mu_i + \frac{\alpha}{n} \sum_{j=1}^{n} D_{ij} \xi_j + \eta \beta_i \frac{\alpha(1-\alpha)}{n} \sum_{j=1}^{n} \left[D W' D \right]_{ij} \xi_j \tag{7}
$$

where $D = [I_n - (1-\alpha) W']^{-1}$ and I_n is the $(n \times n)$ identity matrix. Equation (7) is the basis for the empirical specifications that we propose in the next section.

III Empirical approach

Various representations have been introduced in the literature to act as empirical proxies for firm activity. Measures include value added per worker (Gabaix (2011)), total factor productivity (Carvalho and Gabaix (2013))) and employment (Moscarini and Postel-Vinay (2012)). We follow di Giovanni, Levchenko, and Méjean (2014) that look into the development of sales, resulting in the following representation of firm activity:

$$
y_i \equiv ln(sales_i). \tag{8}
$$

We motivate this choice by the fact that trade credit is measured as a proportion of sales supplied with a deferred payment.

Our interest is in particular with the transmission mechanism of shocks originating at supplier's production processes. To that end we quantify idiosyncratic shocks ξ_i in a manner similar to Gabaix (2011), that is we set the idiosyncratic shock to be a deviation from a particular benchmark. Similar to Gabaix (2011), we set this benchmark to be equal to average of $ln(sales)$ of all firms in the economy, denoted with $\bar{y}_E$, proxied by all firms in Compustat. The firm-level shock follows as the difference between business' sales and the average sales in the economy:

$$\hat{\xi}_i = y_i - \bar{y}_E. \tag{9}$$

Manski (1993) notices a *reflection problem*: firms' activity might be volatile due to common shocks, but not necessarily vice versa. To address this reflection problem, we use various measures for the idiosyncratic shocks. Alternative specifications include deviations relative to developments in an industry or in a region. For example, the industry benchmark ($\bar{y}_I$) is given by the average sales of firms in a particular industry and to define industry we use the four digit SIC classification. The region benchmark is given by the average sales value of firms in a region where the region is defined by the state ($\bar{y}_S$) or county ($\bar{y}_C$) of the firm's headquarter. Those specifications work under the assumption that the firms respond to the common factors with the same sensitivity.

We follow the literature (Gabaix (2011), di Giovanni, Levchenko, and Méjean (2014), etc.) and look into the growth rate of firm's activity and in particular into growth rate of sales. Define the growth rate of sales for firm i as $g_i = \Delta y_i$,which is the difference in log sales from one year to the other and define the difference in shock for firm i as $e_i = \Delta\xi_i$, which is the change in log sales from one year to the other relative to the change in their benchmark. The resulting empirical relationship follows by taking first differences in equation (7):

$$g_i = \phi \left\{ \sum_{j=1}^{n} \left(\frac{\alpha}{n} D_{ij} \right) e_j \right\} + \eta \left\{ \sum_{j=1}^{n} \beta_i \frac{\alpha(1-\alpha}{n} \left[DW'D \right]_{ij} e_j \right\} + \varepsilon_i \qquad i = 1, \ldots, n \tag{10}$$

The first term in equation (10), which we refer to as the *production process exposure*, depicts the relationship between a customer's sales growth and the production linkages in the absence of trade credit linkages, or if trade credit does not matter for transmission of idiosyncratic shocks. It is a weighted sum of firm-level suppliers' shocks, where the weights depend on the relative importance of the suppliers for a customer's production process. A parameter ϕ has been included in this first term. From the theoretical model in equation (7) we expect the estimate of parameter ϕ to be equal to one.

The second term in equation (10), which we refer to as *trade credit exposure*, is a weighted sum of firm-level suppliers' shocks with weights determined by both suppliers' importance in delivering inputs and their position as trade credit providers. In that second term, parameter Îů indicates the importance of the trade credit channel in the transmission of firm-level shocks. Positive values of η amplify the shocks to the production process, while negative values insure against them. If $\eta = 0$, the trade credit channel is irrelevant for the transmission of shocks between firms.

Equation (10) includes parameters α, β_i, W and D. In the next section we will propose proxies for these parameters. The remaining parameters ϕ and η are the focus of this study, and will be estimated by minimizing the sum of squared $(\sum_{i=1}^{n} \varepsilon_i^2)$. In particular, we test the hypothesis about the role of trade credit in transmitting idiosyncratic shocks by looking if the parameter η is different from zero. In normal times, we expected the estimate of η to be negative and significantly associated with customers' sales growth. However, during recessions or in case of financially constrained firms, we expect η to be zero or positive as trade credit may amplify shocks to customers in a manner of Kiyotaki and Moore (1997).

In the empirical part, we also want to verify that the correlation between shocks to suppliers and sales growth of their customer is not driven by either a common shock or by a reverse causal relationship from customer to supplier.

To do so we first evaluate if shocks to suppliers are spuriously correlated with customer's sales growth as a result of exposure to common shocks. We address this problem by the way in which shocks to suppliers are computed. To that end, we disentangle the common component from the firm-level component by demeaning suppliers' growth rate on the economy, industry, state and county level. In other words, suppliers' shocks are equivalent to suppliers' excess growth relative to an economy, industry, state and county benchmark. The excess growth is meant to be firm-specific and represent the idiosyncratic component of their sales growth.

To even more explicitly tackle the issue of common shocks imagine the following scenario. Consider a supplier linked to two customers A and B by an equal production process relationship and a different trade credit relationship. Customer A operates in the same four digit SIC industry as the supplier and receives low trade credit. In contrast, customer B operates in another industry and receives high trade credit. Now, if a positive common shock affects the industry in which the supplier and customer A operate, the supplier experiences a positive shock (positive excess growth) relative to the economy benchmark and the customer A grows at a higher rate. On the other hand, customer B does not reap the benefits of this positive common shock and grows at a lower rate. The lower growth rate of customer B can seem to be related to the higher trade credit ratio rather than when in fact it is due to missing on the positive common shock. If for some reason[4] customers tend to have a lower trade credit relationship with their suppliers in the same industry or in the same location, the effect of common shocks can be controlled for by time varying industry effects or time varying location fixed effects.

To address the second issue, we notice that a reverse causal relationship would imply a transmission mechanism that works from customer to supplier, where a high growth rate of a customer would trigger a positive shock to its supplier, but less so with increase in trade credit. Cases where development in customer growth is followed by a response in its suppliers' excess growth should intuitively involve customers which are important and strategic to their suppliers. Purchases from those strategic customers correspond to a high share of suppliers' sales and swings in their demand are more likely to be reflected in excess growth of their suppliers. By focusing on a sub-sample of customers that are strategic to their suppliers, we allow for the reverse causal relationship to be revealed. In this sub-sample

[4] For example, if firms use trade credit to deal with information asymmetry of their production partners by screening firms in a different industry rather than those operating in the same industry (Smith (1987)).

a reverse causal relationship manifest itself by an increased correlation. In the results section we will explicitly investigate this case.

IV Data

At the heart of our data is a list of customer-supplier pairs. Under the Statement of Financial Accounting Standards - SFAS No. 131 a firm need to disclose certain information on its operating segments. In particular, firms is required to reveal the identity of its major customers that purchase above 10% of their sales. We use a sample of such customer-supplier pairs identified by Cohen and Frazzini (2008) based on Compustat Segments information. The sample assigns CRSP's *permno* to each individual firm. This allows to match the customer-supplier pairs identified by Cohen and Frazzini (2008) with CRSP-Compustat's balance sheet information.

In particular, we focus our analysis on customer-supplier pairs in which customers operate in manufacturing, transportation, wholesale and retail trade (SIC code 2000-5999). The customer-supplier pairs are required to have a match to Compustat balance sheet information, non-missing values of assets, non-missing values of cost of goods sold, and non-missing values of sale in two consecutive years. The final set contains 4,785 unique customer-year observations. Each of these observations is connected on average to 2.71 suppliers with a total of 12,985 unique customer-supplier-year observations that represent 4,929 distinct customer-supplier pairs over the years 1980 to 2004.

The customers reported in Panel A of Table I tend to be larger than the suppliers in Panel D. This discrepancy is partially due to the way the customer-supplier paris are identified. The customers reported in Compustat Segments, and therefore in the Cohen and Frazzini (2008) sample, are those that correspond to at least 10% of sales. Those firms are inclined to be larger with assets on average almost 13 times higher and sales 14 times higher than the sample of suppliers. During the entire sample period, on average both customers and suppliers experience a positive sales growth rate (g). The average customers' sales growth is illustrated in Figure 2. For most of the time it stays positive with short episode of negative growth in 2002.

In our analysis we approximate parameters and variables from equation (10) to obtain three sets of information used in estimation of equation (10). First set of information relates to weights attributed to supplier shocks that compose the production linkage. The second set of information relates to weights attributed to supplier shocks that compose trade credit linkage. The third set of information are the supplier shocks.

First, to compute the weights defining the production linkage, we approximate parameter (w_{ij}) and parameter (α). The parameter (w_{ij}) is said to capture the amount spent on input j per dollar of production of firm i. On a firm-level, we approximate it by the ratio of sales from supplier (firm j) to customer (firm i) over the customer's cost of goods sold (Compustat item *cogs*). It represents the amount customer i spent on inputs from supplier j per dollar amount of its production cost. On average, about 4.2% of customer's inputs come from one of its suppliers. Also, the labor income share denoted by α is assumed to be constant over the whole economy and takes a value of 0.61. We compute it from the OECD data on Unit Labor Costs as the average of Labor Income Share (Real ULC) over the years from 1995 to 2004 that is over the years the Labor Income Share is available.

Second, to compute the weights defining the trade credit linkage, we compute the share of trade credit received by a customer (β). To this end we follow Raddatz (2010) and measure β as the ratio of customer's accounts payable (Compustat item *ap*) over its cost of goods sold (Compustat item *cogs*). It depicts the proportion of purchased inputs with deferred payment and typically reflects the share of goods that the customer purchased on trade credit. Since we do not observe the share of trade credit contributed by individual suppliers, we assume this share is equal across all suppliers delivering to a given customer. In our sample, customers buy about 15% of their inputs on trade credit. Their dependence on trade credit is comparable with the U.S. firms in Raddatz (2010) which finance about 13% of inputs with trade credit.[5] Figure 3 illustrates the time series development of the proportion of inputs delivered on trade credit in our sample. Over the period of 25 year

[5]Raddatz (2010) sample includes a universe of U.S. firms in Compustat over a similar time period.

there is an increase in the amount of trade credit used with a slight drop during recessions.

Lastly, we quantify supplier shocks ($\hat{e}$) as a deviation from a benchmark. The benchmark is given by an average sales growth among a group of firms, to which the supplier belongs. We take the Compustat universe of firms to compute the economy sales growth ($\bar{g}_E$) as the average growth among all the Compustat firms. Next, we categorize firms into industries based on the four digit SIC code to compute the industry benchmark as an average for sales growth among firms in the same industry. We repeat that exercise and compute the state benchmark as an average for sales growth among firms in the same U.S. state and the county benchmark as an average for sales growth among all firms operating in the same county.

Figure 4 illustrates the time series evolution of the supplier shocks estimated relative to economy, industry, state and county benchmark. There is a considerable commonality between the supplier shocks and the average sales growth rate among suppliers. In general, their behavior is closely related and both values co-move together. For example, during the NBER recessions, illustrated by the shaded areas, both the benchmark and the average behavior of suppliers tend to drop considerably.

In Table II we examine the correlations between customer and supplier sales growth, and the benchmarks. The correlations are computed from yearly observations pooled across all the customer and supplier firms. At the bottom of column (2) we report the correlations between supplier sales growth and the shocks to customer sales growth using different benchmarks. The high correlation indicates that there is a considerable commonality between disturbance to customer sales growth and their suppliers' sales growth. High deviations of customer sales growth are associated with high supplier sales growth. Also, customer sales growth tends to be correlated with shocks to their suppliers.

V Empirical results

Our analysis thus far results in an empirical strategy that consists of four steps. First, we establish whether shocks to suppliers are indeed transmitted through the production network and find out how different elements of that production network - input delivery and trade credit - contribute to the direction and magnitude of that transmission process. Next, we dsicover how common shocks effect the impact of both elements on the transmission process. Third, we verify how robust our distinction between these two elements is. Finally, we delve deeper into the role of trade credit as an elusive insurance mechanism.

A Shock transmission through a production network

From our theoretical model in Section II, we learnt that, in general, the use of credit in the customer-supplier relationship can work as insurance against shocks to suppliers and may reduce disturbances to customers' sales. Whether those shocks to suppliers are transmitted through the production network and, which part of the production network - input delivery or trade credit - plays a crucial role, is answered in Table III.

Based on the model, we expect the relationship between sales growth and production linkage (ϕ) to be positive and significant, as the change to customers' sales should be greater with a greater shock to its crucial suppliers of inputs. Likewise, we expect the relationship between customers' sales growth and trade credit linkage (η) is expected to be negative since trade credit is expected to act as insurance against supplier shocks.

We start in Column (1) of Table III with a basic test of both hypotheses. Indeed, we find that production linkages propagate shocks from a supplier onto its customer. Also, the use of trade credit reduces the severity of shocks and acts as an insurance. Once we start controlling for fixed effects in Column (2), both results appear to be robust.

Both effects are also economically sizable. Depending on the specification, a customer experiences about 20-25% lower disruption to its sales from a shock to its supplier if a trade credit linkage exists next to a production linkage. Moreover, in absence of trade credit a one standard deviation positive (negative) shock to all suppliers increases (decreases) customer's sales growth by about 0.50%. If trade credit accompanies that same production linkage the disturbance is lower and amounts to about 0.40%.[6]

[6] Note that our matrix of linkages is not exhaustive and we are missing the customer-supplier linkages that do not pass the 10% threshold to be reported in the Compustat Segments database. However, we believe that in the limit those connections could be approximated by the industry or state or county benchmark. In turn this leaves those connections with no impact on the analysis as their shocks are equal to zero.

B The transmission of common shocks

In our analysis so far, we have implicitly assumed that a shock affects a single supplier, and has no direct impact on others. In the next subsection, we deal with the possibility of shocks to customers. Here, we address the possibility of a common shock to suppliers and customers in the same industry or state.

Imagine a positive common shock to a given industry (or state) at a given point in time. Contrast one customer-supplier pair that operates in the affected industry with a second customer-supplier pair with a customer operating in another industry and the supplier operating in the affected industry. In the former case, the high correlation between the state of the customer and the state of its supplier could result from their exposure to the common shock rathe than from a trade credit linkage. In the latter case, however, the customer is not directly exposed to the shock and any correlation between its state and that of its supplier is more likely to common from trade credit usage in the absence of exposure to the common shock.

Our objective, then, is to isolate the effect of common shocks from the effects of production and trade credit linkages by means of time varying industry and state fixed effects. Results are reported in columns (3) and (4) of Table III and appear robust to common shocks. Customers are affected more by shocks to crucial suppliers of inputs but less so if trade credit accompanies the production linkage. These results are in line with Gao (2014), who shows that in a tight network of customer-supplier relationships, a liquidity shock to one firm triggers a flow of liquidity from other parts of the network. One example is Bosch that supported its liquidity-constrained suppliers by offering them forward payments and reimbursement of raw materials. Such a behavior of firms can dampen shocks to any of the firms in such a liquidity rich networks.

C Distinguishing between trade credit and production linkages

Until now, we have established that network linkages, both related to production and to trade credit, affect the transmission of shocks. Now, we put more effort into distinguishing between the strength of the production linkage and the trade credit linkage, respectively.

We start in Column (1) of Table IV by repeating our analysis for a sub-sample of firms with very low shares of trade credit. For these firms, the production process forms the base for their interconnections with suppliers. Hence, we expect to find that the trade credit linkage has a negligible effect on sales growth for this sub sample. Indeed, our results show that for this group the production linkage is the only channel through which shocks are transmitted.

In Column (2) of Table IV, we take the above examination one step further and drop the trade credit linkage from our analysis. As a result, we effectively estimate the Acemoglu et al. (2012) model, in which it is assumed that only production linkages can propagate shocks from suppliers onto their customers. If trade credit has an insurance effect, we expect to understate the size of the production linkage in this estimation. Indeed, that is what we find.

Next, in Column (3) we provide a more direct comparison of our results with the predictions from the Acemoglu et al. (2012) model, by constraining the coefficient of the production linkage at its theoretical value, equal to one. From the Table, we observe that the economic magnitude of the trade credit linkage remains unchanged.

Finally, in Column (4) we focus on a subsample of strategic customers, who are of particular importance for their suppliers. Doing so, allows us to address possible reverse causality issues. After all, a change in a firm's state can originate on the supplier side (downstream propagation) or on the customer side (upstream propagation). Our aim is to capture downstream propagation, not upstream propagation. In the latter case, if a strategic customer grows at a high rate, as a consequence its supplier is expected to have a positive boost in its sales and is likely grow at a rate higher than the rest of the economy. Thus, focusing on a subsample of strategic customers should increase the scope of upstream propagation while diminishing the downstream propagation provides us with a perfect testing ground of possible reverse causality. For each customer, we find its minimum share in suppliers' sales. Next, we rank all customers according to that minimum. Results in Column (4) show that the top decile most strategic customers do not exhibit a higher correlation with their suppliers' excess growth, confirming that our analysis (mainly) captures the downstream propagation of shocks from suppliers onto their customers.

D Trade credit as an elusive insurance

In this final part of our analysis, we focus in more detail on the role of trade credit. Thus far, we have found that both production linkages and trade credit linkages play an important role in the downstream transmission of shocks. On the face of it, trade credit appears to act as an insurance against disruptions caused by supplier shocks: after a negative shock to its supplier, a customer grows at a higher rate than it would have grown had it not received any trade credit.

Here, we study just how reliable the implicit insurance offered by trade credit is in practice by zooming in on those customers that are indeed financially constrained. Of course it is possible that suppliers end trade credit once a customer becomes financially constrained. However, Panels B and C of Table I provide evidence to the contrary: we do not observe significant drop in trade credit provision during recessions. Therefore, we re-estimate equation (10) and include a measure of how financially constrained a customer is, which we then also interact with the trade credit linkage. If trade credit is a durable and reliable insurance against shocks from production partners, the interaction term should be negative and significant or at least insignificant.

Table V contains our estimation results for three different measures of how financially constrained a customer is. The simplest measure is included in Column (1), where we concentrate on recessions, when a large number of firms is expected to be financially constrained. As it turns out, during recessions trade credit does not insure customers against shocks propagated from their suppliers. Firms with high trade credit are systematically less able to reap the benefits of positive developments in good times and in bad times are in general less resilient to shocks propagating from their suppliers.

We continue this line of thought in Column (2), where we define firms to financially constrained if in a given year their cash reserves (relative to their sales) are in the bottom 5 percentile. For such cash poor firms, we observe a contagion similar to Kiyotaki and Moore (1997) where trade credit not only is a very poor insurance against shocks from suppliers but it also amplifies those shocks and further destabilizes customers' sales. The same can be said of the results in Column (3), where we consider firms to be financially constrained following Rajan and Zingales (1998), who measure firms' dependence on external finance.[7] Again, trade credit fails to provide insurance for the most vulnerable firms. For the top decile of most financially constrained firms, it does not matter if the firm is using trade credit or not: the shock to its supplier will hit it with the same strength. In Column (5), we combine the analysis in Columns (3) and (4) and report the results for firms dependent on external finance *during* a recession: as expected both effects reinforce each other.

As a final step, we challenge these results by once again controlling for common shocks and reverse causality. Table VI reports the results for recession times and the Rajan and Zingales (1998) measure of firm's dependence on external finance. In Columns (1) and (2), we include time varying fixed effects and control for the effect of common shocks. Our findings and the economic magnitude of the effects remains unchanged. Columns (3) and (4) tackle the issue of reverse causality by again including an indicator if a customer has many heavily reliant suppliers. With no increase in correlation for those customers we find no evidence of reverse causality. Results are also robust to using an industry benchmark where shocks are computed as a deviation from the industry average (Table VII), to using a state benchmark in which suppliers shocks are computed as a deviation from the state average (Table VIII) and to using a county benchmark in which suppliers shocks are computed as a deviation from the county average (Table IX).

[7] They use the ratio of capital expenditures (Compustat item *capx*) reduced by sum of funds from operations (*fopt*), inventory (*invch*), accounts receivable (*recch*) and accounts payable (*apalch*) to capital expenditures.

VI Concluding remarks

This paper finds that the transmission of shocks downstream depends both on the strength of the production linkage between suppliers and customers and on the extent to which the former provide trade credit to the latter. Not accounting for the trade credit linkage result in an overestimation of the importance of the production linkage, since the trade credit linkage on average mitigates the impact of shocks.

Once we delve deeper into these findings, however, we find that trade credit is an elusive insurance against shocks from production partners. The insurance aspect of trade credit only works if customers do not need it, i.e., if they are not financially constrained. Once this is not the case, trade credit further lowers sales stability and provide no insurance against shocks propagating downstream from suppliers.

Our results are robust to common shocks and appear not to be affected by possible upstream propagation of shocks. Also, the results hold for a broad range of measures of how financially constrained a firm is.

The main takeaway from our analysis is that firms may overestimate the importance of trade credit. The latter can be seen as an important element of building a relationship between customers and suppliers, and can reflect the trust that both parties have in that relationship. However, the economic value that customers can attach to trade credit is in fact lowest when they may need it the most: when they are financially constrained and/or find themselves in a recession.

From a broader perspective, this paper provides further evidence on how trade and finance interact and inform optimal production decisions in an environment where shocks impede long-run optimal decision making.

Appendix A Competitive equilibrium

We derive the competitive equilibrium by following closely Acemoglu et al. (2012). The competitive equilibrium is a set of commodity prices p_i, wage h and consumption choices

c_i that satisfy the representative household's utility maximization problem; firms' profit maximization problem subject to condition that the commodity and labor markets clear, that is:

$$c_i + \sum_{j=1}^{n} x_{ij} = x_i \tag{A1}$$

$$\sum_{i=1}^{n} l_i = 1 \tag{A2}$$

From the firm i profit maximization problem subject to labor and input choices, l_i and x_{ij} respectively, we obtain:

$$l_i = \frac{\alpha x_i p_i}{h} \tag{A3}$$

$$x_{ij} = \frac{x_i p_i (1-\alpha)(1-\beta+b\beta)}{p_j} \tag{A4}$$

In the next step we substitute the optimal labor and input choices into the production function. By taking logs and simplifying we arrive at the following expression:

$$\begin{aligned} \alpha ln(h) =& \alpha\xi_i + C + ln(p_i) + (1-\alpha)(1-\beta+b\beta)\sum_{j=1}^{n} w_{ij} ln(w_{ij}) \\ &- (1-\alpha)(1-\beta+b\beta)\sum_{j=1}^{n} w_{ij} ln(p_j) \end{aligned} \tag{A5}$$

where C is a constant independent of prices, wage and consumption defined as:

$$C = \alpha ln(\alpha) + (1-\alpha)ln(1-\alpha) + (1-\alpha)ln(1-\beta+b\beta) \tag{A6}$$

Next we multiply by the ith element of the u vector and we sum over all i.

$$\begin{aligned} \sum_{i=1}^{n} u_i ln(h) =& \sum_{i=1}^{n} u_i\xi_i + \frac{C}{\alpha}\sum_{i=1}^{n} u_i + \frac{1}{\alpha}\sum_{i=1}^{n} ln(p_i)u_i \\ &+ \frac{(1-\alpha)}{\alpha}(1-\beta+b\beta)\sum_{i=1}^{n}\sum_{j=1}^{n} u_i w_{ij} ln(w_{ij}) \\ &- \frac{(1-\alpha)}{\alpha}(1-\beta+b\beta)\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij} ln(p_j) u_i \end{aligned} \tag{A7}$$

Denote the vector of logarithm prices by $ln(p)$ then then the expression:

$$\frac{1}{\alpha}\sum_{i=1}^{n} ln(p_i)u_i - \frac{(1-\alpha)}{\alpha}(1-\beta+b\beta)\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}ln(p_j)u_i \tag{A8}$$

in vector notation is equal to:

$$\frac{1}{\alpha}ln(p)u - \frac{(1-\alpha)}{\alpha}(1-\beta+b\beta)ln(p)W'u = \frac{1}{\alpha}ln(p)\left[I - \frac{(1-\alpha)}{\alpha}(1-\beta+b\beta)W'\right]u \tag{A9}$$

With $u = \frac{\alpha}{n}\left[I-(1-\alpha)(1-\beta+b\beta)W'\right]^{-1}\mathbf{1}$ the expression in (A9) simplifies to:

$$\frac{1}{\alpha}ln(p)u - \frac{(1-\alpha)}{\alpha}(1-\beta+b\beta)ln(p)W'u = \frac{1}{n}ln(p)\mathbf{1} \tag{A10}$$

From constant returns to scale we have that $\sum_{i=1}^{n} u_i = 1$. We use this property to obtain that:

$$y = \mu + u'\xi \tag{A11}$$

$$\text{where} \quad u = \frac{\alpha}{n}\left[I-(1-\alpha)(1-\beta+b\beta)W'\right]^{-1}\mathbf{1} \tag{A12}$$

$$\text{and} \quad \mu = \frac{1}{n}\sum_{i=1}^{n} p_i + \frac{C}{\alpha} + \frac{1-\alpha}{\alpha}(1-\beta+b\beta)\sum_{i=1}^{n}\sum_{j=1}^{n} u_i w_{ij} ln(w_{ij})$$

The aggregate fluctuations are equal to a sum of all idiosyncratic shocks weighted by the importance of firms in their production and trade credit networks.

Appendix B Taylor expansion

We approximate vector u by taking the first order Taylor approximation of u around $\eta = 0$:

$$u \approx u(0) + \frac{u'(0)}{1!}(\eta - 0) = \frac{\alpha}{n}\left[I-(1-\alpha)W'\right]^{-1}\mathbf{1} + \eta u'(o) \tag{B1}$$

To differentiate vector u we use the property that a derivative of a matrix inverse is equal to:

$$\frac{dM^{-1}}{d\eta} = -M^{-1}\frac{dM}{d\eta}M^{-1} \tag{B2}$$

With the matrix $M = [I - (1-\alpha)(1+\eta\beta)W']$ we get:

$$\begin{aligned}\frac{dM^{-1}}{d\eta} =& -[I - (1-\alpha)(1+\eta\beta)W']^{-1} \\ &\times \frac{d[I - (1-\alpha)(1+\eta\beta)W']}{d\eta}[I - (1-\alpha)(1+\eta\beta)W']^{-1}\end{aligned} \tag{B3}$$

where the derivative of matrix M with respect to η is given by: $\frac{dM}{d\eta} = -(1-\alpha)\beta W'$. This yields that:

$$\begin{aligned}u \approx& \frac{\alpha}{n}[I - (1-\alpha)W']^{-1}\mathbf{1} + \eta\frac{\alpha}{n}[I - (1-\alpha)W']^{-1}(1-\alpha)\beta W'[I - (1-\alpha)W']^{-1}\mathbf{1} \\ =& v + \eta[I - (1-\alpha)W']^{-1}(1-\alpha)\beta W' v.\end{aligned} \tag{B4}$$

Appendix C Firm level relationship

We begin from the aggregate output relationship as in equation (3) in the index notation:

$$y = \mu + \sum_{j}^{n} u_j \xi_j, \tag{C1}$$

where u_j is the jth element of vector u defined as in equation (6):

$$u \approx v + \eta[I - (1-\alpha)W']^{-1}(1-\alpha)\beta W' v, \tag{C2}$$

and the *influence vector* of Acemoglu et al. (2012) is defined as in equation (5):

$$v = \frac{\alpha}{n}[I - (1-\alpha)W']^{-1}\mathbf{1}. \tag{C3}$$

Let us define matrix $D \equiv \frac{\alpha}{n}\left[I-(1-\alpha)\,W'\right]^{-1}$ such that the *influence vector* of Acemoglu et al. (2012) writes as $v = D\mathbf{1}$, then from (C1), (C2) and (C3) we have:

$$y = \mu + \sum_{j=1}^{n} [D\mathbf{1}]_j \xi_j + \eta \sum_{j=1}^{n} \Big[\left(1-(1-\alpha)W'\right)^{-1} (1-\alpha)\beta W' D\mathbf{1} \Big]_j \xi_j, \tag{C4}$$

or summing also in the i dimension:

$$y = \mu + \sum_{i=1}^{n}\sum_{j=1}^{n} D_{ji}\xi_j + \eta \sum_{i=1}^{n}\sum_{j=1}^{n} \Big[\left(1-(1-\alpha)W'\right)^{-1} (1-\alpha)\beta W' D \Big]_{ji} \xi_j. \tag{C5}$$

For $y = \sum_{i=1}^{n} y_i$ the expression in (C5) becomes:

$$\sum_{i=1}^{n} y_i = \mu + \sum_{i=1}^{n}\sum_{j=1}^{n} D_{ji}\xi_j + \eta \sum_{i=1}^{n}\sum_{j=1}^{n} \Big[\left(1-(1-\alpha)W'\right)^{-1} (1-\alpha)\beta W' D \Big]_{ji} \xi_j. \tag{C6}$$

which at the firm level is equivalent to:

$$y_i = \mu_i + \sum_{j=1}^{n} D_{ji}\xi_j + \eta \sum_{j=1}^{n} \Big[\left(1-(1-\alpha)W'\right)^{-1} (1-\alpha)\beta W' D \Big]_{ji} \xi_j. \tag{C7}$$

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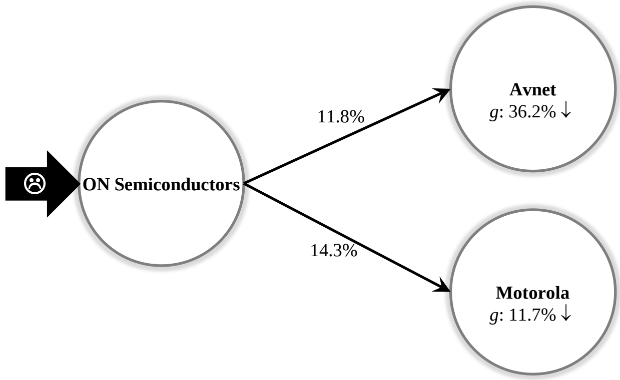
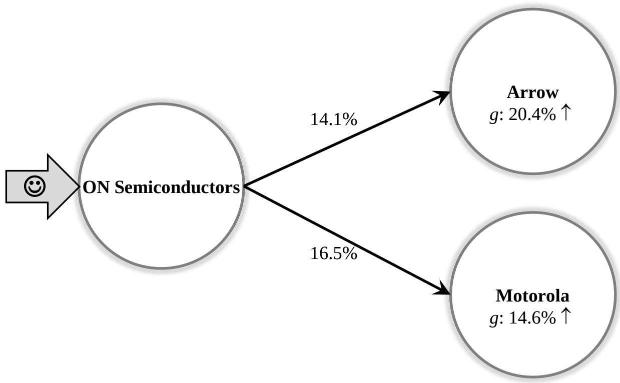


(a) 2002 ON Semiconductor



(b) 2004 ON Semiconductor

Figure 1: Customers' sales growth and shock to supplier. Figure illustrates supply chain relationships in which supplier experiences a positive or negative shock. The figures above the arrows give the amount of trade credit provided and the figures in circles give the corresponding increase or decrease in customer's sales.

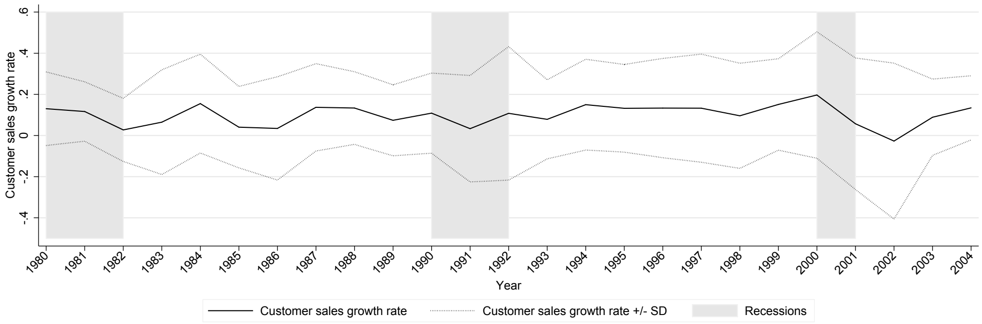


Figure 2: Customers sales growth rate. The figure shows the time series development of the average growth rate of sales among the customers.

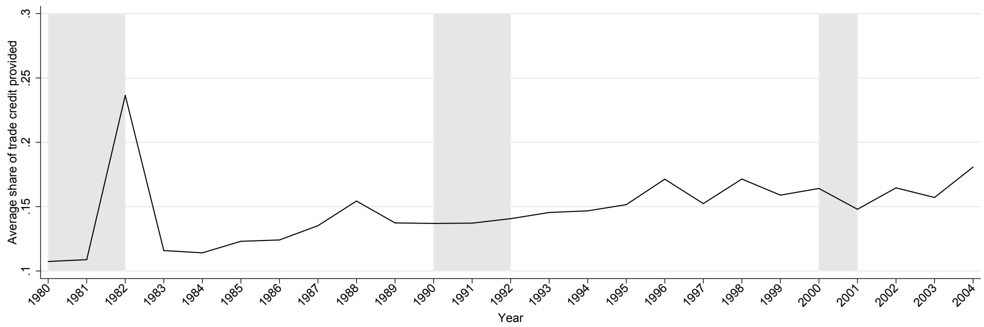
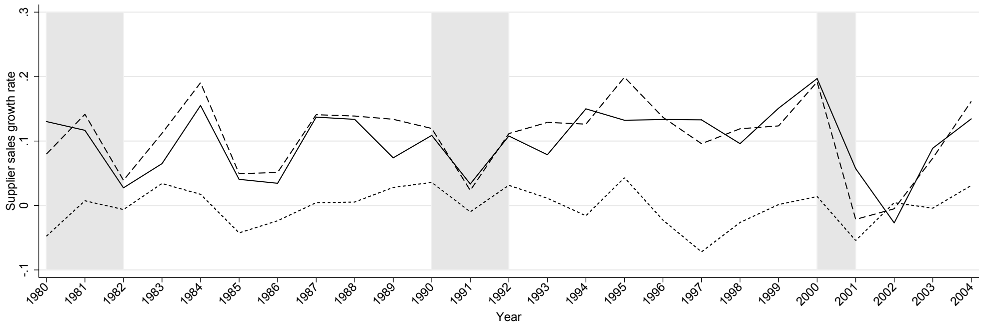
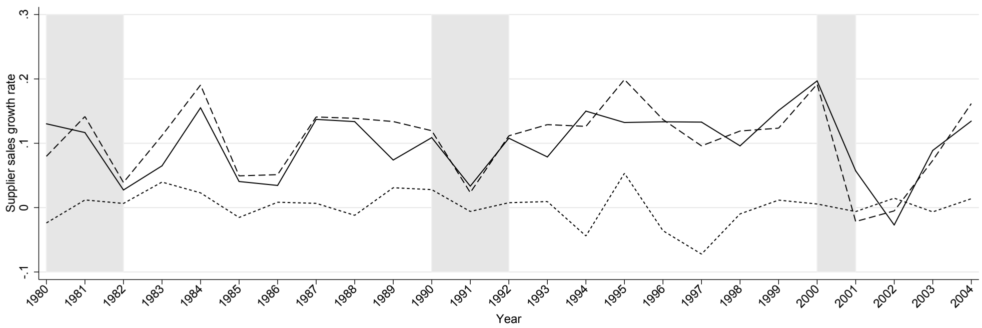


Figure 3: Share of trade credit received β. The figure shows the time series development of the average share of trade credit received β among the customers.

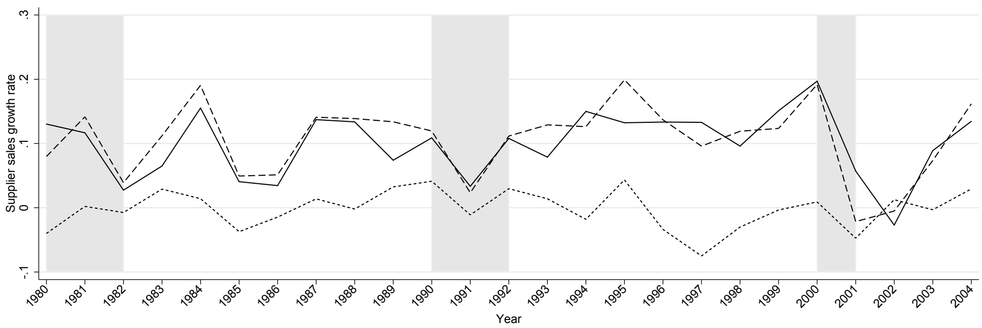
(a) Economy benchmark



(b) Industry benchmark



(c) State benchmark



(d) County benchmark

Figure 4: Suppliers sales growth rate and the benchmark. The figure shows time series development of average growth rate of sales among suppliers. It is benchmarked against the average growth rate in the economy (Panel a), in the industry (Panel b), in the state (Panel c), in the county (Panel d).

Table I

Descriptive statistics

The sample covers firms referred by Cohen and Frazzini (2008) as customers or suppliers with a match to Compustat balance sheet information and non-missing values of assets, cost of goods sold and non-missing values of sale in two consecutive years. Panels A, B and C summarize the sample of customers. Panels D, E and F summarize the sample of suppliers. Recession years are taken from the NBER business cycle reference dates and cover years: 1980, 1981, 1982, 1990, 1991 and 2001. The expansion years cover years: from 1983 to 1989, from 1992 to 2000 and from 2002 to 2004. The production process exposures are computed as $\left(\sum_{j=1}^{n} D_{ji}\hat{e}_j\right)$ which is the first term in equation (10) and the trade credit exposures are computed as $\left(\sum_{j=1}^{n}\left[(1-(1-\alpha)W')^{-1}(1-\alpha)\beta W'D\right]_{ji}\hat{e}_j\right)$ which is the second term in equation (10).

	N	Mean	SD	Min	Max
Panel A: Customers descriptive statistics – Years 1980–2004					
Assets [$ billions]	4,785	12,693.430	29,418.350	1.987	479,921.000
EBIT [$ billions]	4,693	1,062.749	2,287.461	-10,537.000	35,872.000
Sales [$ billions]	4,785	11,664.360	23,008.660	0.436	286,103.000
Accounts payable	4,785	1,127.797	2,540.814	0.000	28,902.600
Cost of goods sold	4,785	8,238.192	17,858.070	0.977	240,391.000
w_{ij}	4,785	0.042	0.176	0.000	5.127
Share of trade credit received β	4,785	0.150	0.279	0.000	17.043
Dependent variable:					
Sales growth rate (g)	4,785	0.099	0.249	-2.832	3.765
Independent variables:					
1) Production process exposures (first term in equation (10)) computed relative to:					
– economy benchmark	4,785	0.002	0.052	-0.781	1.142
– industry benchmark	4,785	0.001	0.067	-3.229	0.958
– state benchmark	4,785	0.002	0.054	-0.751	1.555
– county benchmark	4,785	0.002	0.051	-0.781	1.387
2) Trade credit exposures (second term in equation (10)) computed relative to:					
– economy benchmark	4,785	0.000	0.012	-0.266	0.710
– industry benchmark	4,785	0.000	0.012	-0.315	0.616
– state benchmark	4,785	0.000	0.011	-0.281	0.580
– county benchmark	4,785	0.000	0.012	-0.266	0.695
Panel B: Customers descriptive statistics – Expansion					
w_{ij}	3,782	0.041	0.182	0.000	5.127
Share of trade credit received β	3,782	0.151	0.145	0.000	4.369
Dependent variable:					
Sales growth rate (g)	3,782	0.106	0.251	-2.832	3.765
Independent variables:					
1) Production process exposures (first term in equation (10)) computed relative to:					
– economy benchmark	3,782	0.002	0.054	-0.781	1.142
– industry benchmark	3,782	0.000	0.073	-3.229	0.958
– state benchmark	3,782	0.002	0.056	-0.751	1.555
– county benchmark	3,782	0.002	0.052	-0.781	1.387
2) Trade credit exposures (second term in equation (10)) computed relative to:					
– economy benchmark	3,782	0.000	0.007	-0.266	0.148
– industry benchmark	3,782	0.000	0.009	-0.315	0.149
– state benchmark	3,782	0.000	0.007	-0.281	0.152
– county benchmark	3,782	0.000	0.007	-0.266	0.148

Table I cont.

Panel C: Customers descriptive statistics – Recession					
w_{ij}	1,003	0.043	0.154	0.000	2.612
Share of trade credit received β	1,003	0.146	0.541	0.007	17.043
Dependent variable:					
Sales growth rate (g)	1,003	0.074	0.242	-2.045	2.311
Independent variables:					
1) Production process exposures (first term in equation (10)) computed relative to:					
– economy benchmark	1,003	0.001	0.045	-0.397	0.541
– industry benchmark	1,003	0.003	0.043	-0.277	0.578
– state benchmark	1,003	0.002	0.045	-0.404	0.535
– county benchmark	1,003	0.001	0.045	-0.398	0.538
2) Trade credit exposures (second term in equation (10)) computed relative to:					
– economy benchmark	1,003	0.001	0.023	-0.021	0.710
– industry benchmark	1,003	0.001	0.020	-0.024	0.616
– state benchmark	1,003	0.001	0.019	-0.021	0.580
– county benchmark	1,003	0.001	0.022	-0.021	0.695
Panel D: Suppliers descriptive statistics – Years 1980–2004					
Assets [$ billions]	9,383	946.294	4,417.068	0.251	188,874.000
EBIT [$ billions]	9,292	76.940	492.240	-5,281.200	12,863.000
Sales [$ billions]	9,383	830.639	3,496.323	0.016	80,514.600
Accounts payable	9,380	79.916	376.951	0.000	8,946.788
Cost of goods sold	9,383	570.839	2,629.067	0.000	76,956.000
Sales growth rate (g)	9,383	0.101	0.452	-2.994	6.367
Shock ($\hat{e}$) computed relative to:					
– economy benchmark	9,383	-0.002	0.448	-3.172	6.249
– industry benchmark	9,383	0.002	0.427	-3.038	6.136
– state benchmark	9,383	-0.001	0.444	-3.246	6.264
– county benchmark	9,383	-0.001	0.445	-3.172	6.250
Panel E: Suppliers descriptive statistics – Expansion					
Sales growth rate (g)	7,422	0.116	0.460	-2.994	6.367
Shock ($\hat{e}$) computed relative to:					
– economy benchmark	7,422	0.003	0.457	-3.172	6.249
– industry benchmark	7,422	0.003	0.435	-3.038	6.136
– state benchmark	7,422	0.003	0.453	-3.246	6.264
– county benchmark	7,422	0.005	0.453	-3.172	6.250
Panel F: Suppliers descriptive statistics – Recession					
Sales growth rate (g)	1,961	0.043	0.418	-2.552	3.875
Shock ($\hat{e}$) computed relative to:					
– economy benchmark	1,961	-0.021	0.415	-2.585	3.791
– industry benchmark	1,961	0.001	0.391	-2.414	3.715
– state benchmark	1,961	-0.017	0.410	-2.568	3.707
– county benchmark	1,961	-0.021	0.412	-2.585	3.787

Table II

Correlation between customer sales growth and supplier sales growth

Pairwise correlation coefficients are calculated over all 12,985 observations which cover customer–supplier pairs polled over all years with non-missing values of assets, cost of goods sold and non-missing values of sale in two consecutive years. The sales growth among customers is denoted by g_C and among supplier by g_S. The economy benchmark is denoted by $\bar{g}_{Eco}$, the industry benchmark by $\bar{g}_{Ind}$, the state benchmark by $\bar{g}_{Sta}$, and the county benchmark by $\bar{g}_{Cou}$. The shock calculated relative to the economy benchmark is denoted by $\hat{e}_{Eco}$, relative to the industry benchmark by $\hat{e}_{Ind}$, relative to the state benchmark by $\hat{e}_{Sta}$, relative to the county benchmark by $\hat{e}_{Cou}$

	g_C	g_S	$\bar{g}_{Eco}$	$\bar{g}_{Ind}$	$\bar{g}_{Sta}$	$\bar{g}_{Cou}$	$\hat{e}_{Eco}$	$\hat{e}_{Ind}$	$\hat{e}_{Sta}$	$\hat{e}_{Cou}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
g_C	1.000									
g_S	0.155	1.000								
$\bar{g}_{Eco}$	0.223	0.131	1.000							
$\bar{g}_{Ind}$	0.216	0.332	0.390	1.000						
$\bar{g}_{Sta}$	0.207	0.179	0.714	0.363	1.000					
$\bar{g}_{Cou}$	0.153	0.177	0.610	0.278	0.476	1.000				
$\hat{e}_{Eco}$	0.128	0.992	0.005	0.286	0.090	0.102	1.000			
$\hat{e}_{Ind}$	0.080	0.930	-0.013	-0.038	0.048	0.079	0.940	1.000		
$\hat{e}_{Sta}$	0.118	0.982	-0.003	0.268	-0.009	0.090	0.991	0.936	1.000	
$\hat{e}_{Cou}$	0.125	0.979	0.007	0.280	0.083	-0.028	0.987	0.928	0.979	1.000

Table III

Trade credit linkages as insurance against supplier's shocks

The table shows that in general trade credit works as insurance against supplier's shocks by reducing disturbances to customer's sales growth. The table shows coefficient estimates of the equation (10), in which the dependent variable is the sales growth among customers and the supplier shock is computed relative to economy benchmark. Column (2) shows that the effect exists even if controlling for firm, year, industry and state heterogeneity. Columns (3) and (4) show that the effect persist even if controlling for industry-year common shocks or state-year common shocks. Standard errors in parenthesis. The figures in square brackets represent the economic effect of the production and trade credit linkages, which is the response in a customer's sales growth to a one standard deviation increase in the shock to all of its suppliers. It is given as the average of: $(\phi D_{ji} SD[\hat{e}_j])$ for production linkage and by $\left(\eta \left[(1-(1-\alpha)W')^{-1}(1-\alpha)\beta W'D\right]_{ji} SD[\hat{e}_j]\right)$ for trade credit linkage over all suppliers. The sample runs from 1980 to 2004. All regressions include a constant. Significance is denoted by * at the 90% level, ** at the 95% level and *** at 99% level.

	Dependent variable: Customers sales growth (g)			
	Baseline	F.E.	Time varying F.E.	
	(1)	(2)	(3)	(4)
Production linkages (ϕ)	1.111***	0.966***	0.976***	1.036***
	(0.070)	(0.075)	(0.087)	(0.071)
	[0.005]	[0.004]	[0.004]	[0.004]
Trade credit linkages (η)	-1.210***	-1.406***	-0.676*	-1.019***
	(0.301)	(0.337)	(0.353)	(0.303)
	[-0.001]	[-0.001]	[-0.001]	[-0.001]
Firm F.E.	No	Yes	No	No
Year F.E.	No	Yes	No	No
Industry F.E.	No	Yes	No	No
State F.E.	No	Yes	No	No
Year *Industry F.E.	No	No	Yes	No
Year*State F.E.	No	No	No	Yes
N	4,785	4,349	4,785	4,349
Adj.-R^2	0.050	0.352	0.137	0.127

Table IV

Trade credit and customer's importance

The table shows coefficient estimates of the equation (10), in which the dependent variable is the sales growth among customers and the supplier shock is computed relative to economy benchmark. Column (1) shows that the effect disappears if the trade credit linkage between firms is negligible (β among bottom 10%). Columns (2) shows results for model with only production linkages. Column (3) shows results for constrained regression in which ϕ is constrained to value of one which is predicted by the theory. And column (4) focuses on a sub-sample of customers with suppliers highly dependent on their demand. We test here if the reverse causal relationship, in which the customer's growth drives positive shocks to suppliers, reveals itself by a significant coefficient on the "Top 10% reliant suppliers" term. Standard errors in parenthesis. The figures in square brackets represent the economic effect of the production and trade credit linkages, which is the response in a customer's sales growth to a one standard deviation increase in the shock to all of its suppliers. It is given as the average of: $(\phi D_{ji} SD[\hat{e}_j])$ for production linkage and by $\left(\eta \left[(1-(1-\alpha)W')^{-1}(1-\alpha)\beta W'D\right]_{ji} SD[\hat{e}_j]\right)$ for trade credit linkage over all suppliers. The sample runs from 1980 to 2004. All regressions include a constant. Significance is denoted by * at the 90% level, ** at the 95% level and *** at 99% level.

	Dependent variable: Customers sales growth (g)			
	Low β among bottom 10%	Production linkages only	Constrained regression	Strategic customers
	(1)	(2)	(3)	(4)
Production linkages (ϕ)	1.582***	1.040***	1.000	1.110***
	(0.351)	(0.068)	(constrained)	(0.070)
	[0.007]	[0.004]	[0.004]	[0.005]
Trade credit linkages (η)	19.501	-	-1.090***	-1.212***
	(28.354)		(0.291)	(0.301)
	[0.018]		[-0.001]	[-0.001]
Top 10% reliant suppliers				-0.011
				(0.012)
F.E.	No	No	No	No
N	489	4,785	4,785	4,785
Adj.-R^2 (MSE in column (3))	0.043	0.047	0.243	0.051

Table V
Trade credit and financial constraints

The table shows coefficient estimates of the equation (10), in which the dependent variable is the sales growth among customers and the supplier shock is computed relative to economy benchmark. Column (1) shows that trade credit channel reduces disturbances to customer's sales growth during good times but not during recession. Recession years are taken from the NBER business cycle reference dates and cover years: 1980, 1981, 1982, 1990, 1991 and 2001. The expansion years cover years: from 1983 to 1989, from 1992 to 2000 and from 2002 to 2004. Column (2) shows that for cash poor customers, trade credit channel amplifies disturbances to sales growth. This stems from the positive sign on the interaction term between trade credit linkage and a dummy for cash poor customers. The cash poor customers are defined as 5% customers which in previous year had lowest liquid assets relative to their sales. Column (3) illustrates that for financially constrained firms the existence of trade credit linkage translates into higher disturbances in sales growth from suppliers shocks. Financial constraint is computed according to Rajan and Zingales (1998). Column (4) shows that trade credit linkage translates into higher disturbances in sales growth either during recession or for financially constrained firms. The sample runs from 1980 to 2004. Standard errors in parenthesis. The figures in square brackets represent the economic effect of the production and trade credit linkages, which is the response in a customer's sales growth to a one standard deviation increase in the shock to all of its suppliers. It is given as the average of: $(\phi D_{ji} SD[\hat{e}_j])$ for production linkage and by $\left(\eta \left[(1-(1-\alpha)W')^{-1}(1-\alpha)\beta W'D\right]_{ji} SD[\hat{e}_j]\right)$ for trade credit linkage over all suppliers. All regressions include a constant. Significance is denoted by * at the 90% level, ** at the 95% level and *** at 99% level.

	Dependent variable: Customers sales growth (g)			
	Recession	Cash reserves	Fin. dependence	Fin. dependence in recession
	(1)	(2)	(3)	(4)
Production linkages (ϕ)	1.310***	1.014***	1.237***	1.359***
	(0.075)	(0.093)	(0.074)	(0.077)
	[0.006]	[0.004]	[0.005]	[0.006]
Trade credit linkages (η)	-5.233***	-4.761***	-10.017***	-11.616***
	(0.629)	(0.860)	(1.287)	(1.373)
	[-0.005]	[-0.004]	[-0.009]	[-0.011]
Trade credit linkages*Recession	5.186***			7.418**
	(0.709)			(3.742)
	[0.005]			[0.007]
Recession	-0.031***			-0.031***
	(0.009)			(0.009)
Trade credit linkages*Top 10% dependent on ext. fin.			9.203***	7.710***
			(1.303)	(1.448)
			[0.009]	[0.007]
Top 10% dependent on ext. fin.			-0.071***	-0.069***
			(0.012)	(0.012)
Trade credit linkages*Recession *Top 10% dependent on ext. fin.				-3.528
				(3.798)
				[-0.003]
Trade credit linkages*Bottom 5% cash poor firms		72.219***		
		(20.554)		
		[0.068]		
Bottom 5% cash poor firms		0.035**		
		(0.016)		
F.E.	No	No	No	No
N	4,785	3,245	4,728	4,728
Adj.-R^2	0.063	0.039	0.065	0.073

Table VI

Trade credit and financial constraints - robustness

The table shows coefficient estimates of the equation (10), in which the dependent variable is the sales growth among customers and the supplier shock is computed relative to economy benchmark. Column (1) and (2) control for customer level common shocks and show that during recession firms which high use of trade credit suffer higher disturbances to their sales growth than those with only small use of trade credit. Also, financially constrained firms with high use of trade credit will suffer higher disturbances than financially constrained firms with little trade credit. Recession years are taken from the NBER business cycle reference dates and cover years: 1980, 1981, 1982, 1990, 1991 and 2001. The expansion years cover years: from 1983 to 1989, from 1992 to 2000 and from 2002 to 2004. Column (3) and (4) show no significant relationship for customers with highly dependent supplier therefore no evidence of reverse causal relationship. The sample runs from 1980 to 2004. Standard errors in parenthesis. The figures in square brackets represent the economic effect of the production and trade credit linkages, which is the response in a customer's sales growth to a one standard deviation increase in the shock to all of its suppliers. It is given as the average of: $(\phi D_{ji} SD[\hat{e}_j])$ for production linkage and by $\left(\eta \left[(1-(1-\alpha)W')^{-1}(1-\alpha)\beta W' D\right]_{ji} SD[\hat{e}_j]\right)$ for trade credit linkage over all suppliers. All regressions include a constant. Significance is denoted by * at the 90% level, ** at the 95% level and *** at 99% level.

	Dependent variable: Customers sales growth (g)			
	Time varying F.E.		Strategic customers	
	Recession	Fin. dependence	Recession	Fin. dependence
	(1)	(2)	(3)	(4)
Production linkages (ϕ)	1.221***	1.150***	1.309***	1.236***
	(0.076)	(0.075)	(0.075)	(0.074)
	[0.005]	[0.005]	[0.006]	[0.005]
Trade credit linkages (η)	-4.936***	-10.599***	-5.235***	-10.023***
	(0.658)	(1.431)	(0.629)	(1.287)
	[-0.005]	[-0.010]	[-0.005]	[-0.009]
Trade credit linkages*Recession	4.917***		5.187***	
	(0.735)		(0.709)	
	[0.005]		[0.005]	
Recession	0.176		-0.031***	
	(0.462)		(0.009)	
Trade credit linkages*Top 10%		9.937***		9.208***
dependent on ext. fin.		(1.445)		(1.303)
		[0.009]		[0.009]
Top 10% dependent on ext. fin.		-0.070		-0.071***
		(0.013)		(0.012)
Top 10% reliant suppliers			-0.011	-0.012
			(0.012)	(0.012)
Year*State F.E.	Yes	Yes	No	No
N	4,349	4,308	4,785	4,728
Adj.-R^2	0.138	0.148	0.063	0.065

Table VII
Industry benchmark

Panel A shows that trade credit channel reduces disturbances to sales growth. It shows coefficient estimates of the equation (10), in which the dependent variable is the sales growth among customers and the supplier shock is computed relative to industry benchmark. Panel B shows that the insurance effect is irrespective of the customer's importance, which suggests no reverse causality. Panel C shows that the trade credit insurance effect is absent during recession or for cash poor firms or for financially constrained firms. Panel D shows that the trade credit insurance effect is absent in those cases even if controlling for state-year common shocks. Standard errors in parenthesis. The figures in square brackets represent the economic effect of the production and trade credit linkages, which is the response in a customer's sales growth to a one standard deviation increase in the shock to all of its suppliers. It is given as the average of: $(\phi D_{ji} SD[\hat{e}_j])$ for production linkage and by $\left(\eta \left[(1-(1-\alpha)W')^{-1}(1-\alpha)\beta W'D\right]_{ji} SD[\hat{e}_j]\right)$ for trade credit linkage over all suppliers. The sample runs from 1980 to 2004. All regressions include a constant. Significance is denoted by * at the 90% level, ** at the 95% level and *** at 99% level.

	Dependent variable: Customers sales growth (g)			
Panel A: Trade credit as insurance against supplier's shocks				
	Baseline	F.E.	Time varying F.E.	
	(1)	(2)	(3)	(4)
Production linkages (ϕ)	0.626***	0.539***	0.631***	0.573***
	(0.058)	(0.063)	(0.069)	(0.059)
	[0.003]	[0.002]	[0.003]	[0.002]
Trade credit linkages (η)	-1.531***	-1.552***	-1.283***	-1.420***
	(0.332)	(0.374)	(0.397)	(0.336)
	[-0.001]	[-0.001]	[-0.001]	[-0.001]
Firm F.E.	No	Yes	No	No
Year F.E.	No	Yes	No	No
Industry F.E.	No	Yes	No	No
State F.E.	No	Yes	No	No
Year *Industry F.E.	No	No	Yes	No
Year*State F.E.	No	No	No	Yes
N	4,785	4,349	4,785	4,349
Adj.-R^2	0.024	0.335	0.123	0.099
Panel B: Customer's importance				
	Low β among bottom 10%	Production linkages only	Constrained regression	Strategic customers
Production linkages (ϕ)	1.354***	0.518***	1.000	0.625***
	(0.365)	(0.053)	(constrained)	(0.058)
	[0.006]	[0.002]	[0.004]	[0.003]
Trade credit linkages (η)	-30.921		-2.400***	-1.531***
	(23.411)		(0.305)	(0.332)
	[-0.028]		[-0.002]	[-0.001]
Top 10% reliant suppliers				-0.013
				(0.012)
F.E.	No	No	No	No
N	489	4,785	4,785	4,785
Adj.-R^2 (MSE in column (3))	0.024	0.019	0.248	0.024

Table VII cont.

	Dependent variable: Customers sales growth (g)			
Panel C: Financial constraints				
	Recession	Cash reserves	Fin. dependence	Fin. dependence in recession
	(1)	(2)	(3)	(4)
Production linkages (ϕ)	0.861***	0.616***	0.636***	0.840***
	(0.066)	(0.082)	(0.059)	(0.067)
	[0.004]	[0.003]	[0.003]	[0.003]
Trade credit linkages (η)	-4.990***	-4.820***	-7.031***	-9.133***
	(0.584)	(0.856)	(1.520)	(1.562)
	[-0.004]	[-0.004]	[-0.006]	[-0.008]
Trade credit linkages*Recession	4.367***			7.404**
	(0.603)			(3.040)
	[0.004]			[0.007]
Recession	-0.034***			-0.034***
	(0.009)			(0.009)
Trade credit linkages*Top 10% dependent on ext. fin.			5.724***	4.724***
			(1.524)	(1.575)
			[0.005]	[0.004]
Top 10% dependent on ext. fin.			-0.076***	-0.074***
			(0.012)	(0.012)
Trade credit linkages*Recession *Top 10% dependent on ext. fin.				-4.106
				(3.566)
				[-0.004]
Trade credit linkages*Bottom 5% cash poor firms		14.932		
		(26.059)		
		[0.013]		
Bottom 5% cash poor firms		0.028*		
		(0.016)		
F.E.	No	No	No	No
N	4,785	3,245	4,728	4,728
Adj.-R^2	0.037	0.017	0.033	0.044

Panel D: Financial constraints - robustness	Time varying F.E.		Strategic customers	
	Recession	Fin. dependence	Recession	Fin. dependence
Production linkages (ϕ)	0.810***	0.584***	0.860***	0.635***
	(0.067)	(0.060)	(0.066)	(0.059)
	[0.003]	[0.002]	[0.004]	[0.003]
Trade credit linkages (η)	-5.015***	-8.422***	-4.989***	-7.037***
	(0.607)	(1.709)	(0.584)	(1.520)
	[-0.004]	[-0.007]	[-0.004]	[-0.006]
Trade credit linkages*Recession	4.397***		4.365***	
	(0.621)		(0.603)	
	[0.004]		[0.004]	
Recession	-0.167		-0.034***	
	(0.741)		(0.009)	
Trade credit linkages*Top 10% dependent on ext. fin.		7.228***		5.729***
		(1.712)		(1.524)
		[0.006]		[0.005]
Top 10% dependent on ext. fin.		-0.075		-0.076***
		(0.013)		(0.012)
Top 10% reliant suppliers			-0.012	-0.014
			(0.012)	(0.012)
Year*State F.E.	Yes	Yes	No	No
N	4,349	4,308	4,785	4,728
Adj.-R^2	0.112	0.115	0.037	0.033

Table VIII

State benchmark

Panel A shows that trade credit channel reduces disturbances to sales growth. It shows coefficient estimates of the equation (10), in which the dependent variable is the sales growth among customers and the supplier shock is computed relative to state benchmark. Panel B shows that the insurance effect is irrespective of the customer's importance, which suggests no reverse causality. Panel C shows that the trade credit insurance effect is absent during recession or for cash poor firms or for financially constrained firms. Panel D shows that the trade credit insurance effect is absent in those cases even if controlling for state-year common shocks. Standard errors in parenthesis. The figures in square brackets represent the economic effect of the production and trade credit linkages, which is the response in a customer's sales growth to a one standard deviation increase in the shock to all of its suppliers. It is given as the average of: $(\phi D_{ji} SD[\hat{e}_j])$ for production linkage and by $\left(\eta\left[(1-(1-\alpha)W')^{-1}(1-\alpha)\beta W' D\right]_{ji} SD[\hat{e}_j]\right)$ for trade credit linkage over all suppliers. The sample runs from 1980 to 2004. All regressions include a constant. Significance is denoted by * at the 90% level, ** at the 95% level and *** at 99% level.

	Dependent variable: Customers sales growth (g)			
Panel A: Trade credit as insurance against supplier's shocks				
	Baseline	F.E.	Time varying F.E.	
	(1)	(2)	(3)	(4)
Production linkages (ϕ)	1.049***	0.929***	0.943***	1.019***
	(0.069)	(0.074)	(0.085)	(0.071)
	[0.004]	[0.004]	[0.004]	[0.004]
Trade credit linkages (η)	-1.623***	-1.729***	-0.969**	-1.460***
	(0.345)	(0.383)	(0.419)	(0.348)
	[-0.002]	[-0.002]	[-0.001]	[-0.001]
Firm F.E.	No	Yes	No	No
Year F.E.	No	Yes	No	No
Industry F.E.	No	Yes	No	No
State F.E.	No	Yes	No	No
Year *Industry F.E.	No	No	Yes	No
Year*State F.E.	No	No	No	Yes
N	4,785	4,349	4,785	4,349
Adj.-R^2	0.046	0.351	0.135	0.126
Panel B: Customer's importance				
	Low β among bottom 10%	Production linkages only	Constrained regression	Strategic customers
Production linkages (ϕ)	1.538***	0.951***	1.000	1.048***
	(0.335)	(0.066)	(constrained)	(0.069)
	[0.007]	[0.004]	[0.004]	[0.004]
Trade credit linkages (η)	44.904		-1.549***	-1.625***
	(29.239)		(0.329)	(0.345)
	[0.042]		[-0.001]	[-0.002]
Top 10% reliant suppliers				-0.012
				(0.012)
F.E.	No	No	No	No
N	489	4,785	4,785	4,785
Adj.-R^2 (MSE in column (3))	0.050	0.042	0.244	0.046

Table VIII cont.

	Dependent variable: Customers sales growth (g)			
Panel C: Financial constraints				
	Recession	Cash reserves	Fin. dependence	Fin. dependence in recession
	(1)	(2)	(3)	(4)
Production linkages (ϕ)	1.240***	0.947***	1.134***	1.270***
	(0.074)	(0.093)	(0.072)	(0.076)
	[0.005]	[0.004]	[0.005]	[0.005]
Trade credit linkages (η)	-5.129***	-4.976***	-9.063***	-10.753***
	(0.606)	(0.865)	(1.276)	(1.371)
	[-0.005]	[-0.005]	[-0.008]	[-0.010]
Trade credit linkages*Recession	4.221***			7.447**
	(0.597)			(3.721)
	[0.004]			[0.007]
Recession	-0.032***			-0.031***
	(0.009)			(0.009)
Trade credit linkages*Top 10% dependent on ext. fin.			7.903***	6.710***
			(1.296)	(1.429)
			[0.007]	[0.006]
Top 10% dependent on ext. fin.			-0.072***	-0.070***
			(0.012)	(0.012)
Trade credit linkages*Recession *Top 10% dependent on ext. fin.				-5.007
				(4.592)
				[-0.005]
Trade credit linkages*Bottom 5% cash poor firms		68.379***		
		(19.663)		
		[0.063]		
Bottom 5% cash poor firms		0.033**		
		(0.016)		
F.E.	No	No	No	No
N	4,785	3,245	4,728	4,728
Adj.-R^2	0.058	0.034	0.059	0.067

Panel D: Financial constraints - robustness	Time varying F.E.		Strategic customers	
	Recession	Fin. dependence	Recession	Fin. dependence
Production linkages (ϕ)	1.208***	1.102***	1.239***	1.133***
	(0.076)	(0.073)	(0.074)	(0.072)
	[0.005]	[0.005]	[0.005]	[0.005]
Trade credit linkages (η)	-5.055***	-9.962***	-5.132***	-9.073***
	(0.633)	(1.415)	(0.606)	(1.276)
	[-0.005]	[-0.009]	[-0.005]	[-0.008]
Trade credit linkages*Recession	4.168***		4.222***	
	(0.615)		(0.597)	
	[0.004]		[0.004]	
Recession	0.176		-0.032***	
	(0.462)		(0.009)	
Trade credit linkages*Top 10% dependent on ext. fin.		8.939***		7.911***
		(1.433)		(1.296)
		[0.008]		[0.007]
Top 10% dependent on ext. fin.		-0.070		-0.072***
		(0.013)		(0.012)
Top 10% reliant suppliers			-0.012	-0.013
			(0.012)	(0.012)
Year*State F.E.	Yes	Yes	No	No
N	4,349	4,308	4,785	4,728
Adj.-R^2	0.138	0.146	0.058	0.059

Table IX

County benchmark

Panel A shows that trade credit channel reduces disturbances to sales growth. It shows coefficient estimates of the equation (10), in which the dependent variable is the sales growth among customers and the supplier shock is computed relative to county benchmark. Panel B shows that the insurance effect is irrespective of the customer's importance, which suggests no reverse causality. Panel C shows that the trade credit insurance effect is absent during recession or for cash poor firms or for financially constrained firms. Panel D shows that the trade credit insurance effect is absent in those cases even if controlling for state-year common shocks. Standard errors in parenthesis. The figures in square brackets represent the economic effect of the production and trade credit linkages, which is the response in a customer's sales growth to a one standard deviation increase in the shock to all of its suppliers. It is given as the average of: $(\phi D_{ji} SD[\hat{e}_j])$ for production linkage and by $\left(\eta \left[(1-(1-\alpha)W')^{-1}(1-\alpha)\beta W'D\right]_{ji} SD[\hat{e}_j]\right)$ for trade credit linkage over all suppliers. The sample runs from 1980 to 2004. All regressions include a constant. Significance is denoted by * at the 90% level, ** at the 95% level and *** at 99% level.

	Dependent variable: Customers sales growth (g)			
Panel A: Trade credit as insurance against supplier's shocks				
	Baseline	F.E.	Time varying F.E.	
	(1)	(2)	(3)	(4)
Production linkages (ϕ)	1.181***	1.071***	1.051***	1.116***
	(0.071)	(0.078)	(0.088)	(0.073)
	[0.005]	[0.005]	[0.004]	[0.005]
Trade credit linkages (η)	-1.231***	-1.405***	-0.665*	-1.035***
	(0.305)	(0.341)	(0.359)	(0.307)
	[-0.001]	[-0.001]	[-0.001]	[-0.001]
Firm F.E.	No	Yes	No	No
Year F.E.	No	Yes	No	No
Industry F.E.	No	Yes	No	No
State F.E.	No	Yes	No	No
Year *Industry F.E.	No	No	Yes	No
Year*State F.E.	No	No	No	Yes
N	4,785	4,349	4,785	4,349
Adj.-R^2	0.054	0.357	0.142	0.133
Panel B: Customer's importance				
	Low β among bottom 10%	Production linkages only	Constrained regression	Strategic customers
Production linkages (ϕ)	1.586***	1.109***	1.000	1.179***
	(0.350)	(0.069)	(constrained)	(0.071)
	[0.007]	[0.005]	[0.004]	[0.005]
Trade credit linkages (η)	21.561		-1.038***	-1.232***
	(27.964)		(0.296)	(0.305)
	[0.020]		[-0.001]	[-0.001]
Top 10% reliant suppliers				-0.011
				(0.012)
F.E.	No	No	No	No
N	489	4,785	4,785	4,785
Adj.-R^2 (MSE in column (3))	0.044	0.051	0.243	0.054

Table IX cont.

	Dependent variable: Customers sales growth (g)			
Panel C: Financial constraints				
	Recession	Cash reserves	Fin. dependence	Fin. dependence in recession
	(1)	(2)	(3)	(4)
Production linkages (ϕ)	1.371***	1.118***	1.260***	1.388***
	(0.076)	(0.095)	(0.074)	(0.077)
	[0.006]	[0.005]	[0.005]	[0.006]
Trade credit linkages (η)	-5.144***	-4.575***	-8.665***	-9.989***
	(0.630)	(0.862)	(1.321)	(1.413)
	[-0.005]	[-0.004]	[-0.008]	[-0.009]
Trade credit linkages*Recession	4.983***			5.042
	(0.697)			(3.731)
	[0.005]			[0.005]
Recession	-0.031***			-0.031***
	(0.009)			(0.009)
Trade credit linkages*Top 10% dependent on ext. fin.			7.779***	5.841***
			(1.339)	(1.493)
			[0.007]	[0.005]
Top 10% fin. constrained firms			-0.071***	-0.069***
			(0.012)	(0.012)
Trade credit linkages*Recession *Top 10% dependent on ext. fin.				-1.015
				(3.870)
				[-0.001]
Trade credit linkages*Bottom 5% cash poor firms		71.442***		
		(20.701)		
		[0.066]		
Bottom 5% cash poor firms		0.035**		
		(0.016)		
F.E.	No	No	No	No
N	4,785	3,245	4,728	4,728
Adj.-R^2	0.066	0.044	0.066	0.074

Panel D: Financial constraints - robustness	Time varying F.E.		Strategic customers	
	Recession	Fin. dependence	Recession	Fin. dependence
Production linkages (ϕ)	1.293***	1.176177***	1.370***	1.259***
	(0.077)	(0.075)	(0.076)	(0.074)
	[0.006]	[0.005]	[0.006]	[0.005]
Trade credit linkages (η)	-4.840***	-8.937471***	-5.147***	-8.674***
	(0.659)	(1.485)	(0.630)	(1.321)
	[-0.004]	[-0.008]	[-0.005]	[-0.008]
Trade credit linkages*Recession	4.712***		4.984***	
	(0.723)		(0.697)	
	[0.004]		[0.005]	
Recession	0.176		-0.031***	
	(0.460)		(0.009)	
Trade credit linkages*Top 10% dependent on ext. fin.		8.205***		7.786***
		(1.501)		(1.339)
		[0.008]		[0.007]
Top 10% dependent on ext. fin.		-0.0693123		-0.071***
		(0.013)		(0.012)
Top 10% reliant suppliers			-0.011	-0.012
			(0.012)	(0.012)
Year*State F.E.	Yes	Yes	No	No
N	4,349	4,308	4,785	4,728
Adj.-R^2	0.143	0.150	0.066	0.066