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TSURUTA, Daisuke
Nihon University

UCHIDA, Hirofumi
Kobe University

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Does Trade Credit Absorb Adverse Shocks? *

Daisuke Tsuruta
College of Economics, Nihon University

Hirofumi Uchida†
Graduate School of Business Administration, Kobe University

Abstract

The aim of this paper is to examine whether trade credit contributes to absorbing adverse shocks to firms. If the relaxation of trade credit terms contributes to holding back the level of real activities, firms that postpone payment to suppliers would not reduce the amount of purchases when they encounter exogenous adverse shocks. We test this hypothesis by investigating the relation between the postponement of payment and the reduction in purchase amounts by using data of SMEs obtained from two corporate surveys after the Global Financial Crisis and the COVID-19 shocks. From our analysis, we do not find that firms that postponed the payment are less likely to reduce the amount of purchases, which indicates that trade credit does not contribute to absorbing adverse shocks.

Keywords: Trade credit, Shock, Transmission, Bank loans, Deep pocket
JEL classification: G32, L14

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† Corresponding author: Graduate School of Business Administration, Kobe University, 2-1 Rokkodai, Nada, Kobe 657-8510, Japan. Tel.&Fax.: +81-803-6949, E-mail: uchida@b.kobe-u.ac.jp.

1. Introduction

In the turmoil of crisis events, such as the Global Financial Crisis (GFC) in the late 2000s or the world-wide spread of the COVID-19 in and after 2020, firms receive various adverse shocks to invite shortage of funds. To cope with such shocks, they try to take various measures. Whether they could actually take measures, and of what type, determine the type and the magnitude of material damages that they actually suffer.

A provision of trade credit from suppliers is one of such measures. By relaxing terms of credit payments, or more specifically, by lengthening the duration of credit payments or by increasing the fraction of credit payments to the total payments, firms can obtain additional credit from suppliers to cope with the shortage of funds. To the extent that they obtain such credit from suppliers, firms could prevent contraction of their real activities, such as production, investment, and employment. In this sense, additional credit from suppliers might play a role of a shock absorber.

The main objective of this paper is to examine whether trade credit actually plays this role of a shock absorber. To answer this question, we use two samples of small- and medium-sized enterprises (SMEs) obtained from two corporate surveys in Japan conducted by the Research Institute for Economy, Trade and Industry (RIETI) after the Global Financial Crisis and the COVID-19 shocks. From these surveys, we can take advantage of the information on measures that SMEs actually took after the respective crises, including whether they obtained additional trade credit and whether they reduced the amount of purchases.

Using information from these surveys, we conduct two analyses. The first analysis, Analysis 1, tests the hypothesis that trade credit plays the role of a shock absorber. Specifically, we analyze whether firms that obtain additional trade credit from suppliers do not reduce the amount of purchases, because this is the case where the relaxation of trade credit terms contributes to hold back the level of real activities. In addition to a simple univariate analysis to examine the association between indicators of these measures, we also analyze the

association by controlling for heterogeneity of firms by using a propensity score matching (PSM).

In addition to Analysis 1 where we analyze whether trade credit plays the role of a shock absorber, our second analysis, Analysis 2, analyzes when, or under what circumstances trade credit plays that role. There are four possible cases for the observations in our two samples depending on whether firms lengthen the duration of payment period and whether they reduce the amount of sales. We run a multivariate regression on the selection of these cases. Our primary interest is on the selection of the case of the lengthening and the non-reduction, because it clarifies determinants of trade credit as a shock absorber.

Among such determinants, we focus on two factors: the characteristics of suppliers and measures to banks that firms take to cope with adverse shocks. Suppliers' characteristics are important, because they enable us to examine the so-called deep pocket hypothesis. Firms are connected through a chain of transactional relationships (customer-supplier relationships or a supply chain), and to the extent that the payments to the transactions are made through trade credit, there is also a credit chain (Kiyotaki and Moore 1997). This chain might work as a conduit to transmit a financial shock to one firm to others, but a large financially affordable supplier, a deep pocket, might be able to stop the transmission by extending credit to its customer and absorb the shock (Meltzer 1960 and Kiyotaki and Moore 1997).

Measures to banks are also an important factor, because firms that could obtain emergency finance from banks might not have to rely on additional trade credit from suppliers. Studies on the real effect of trade credit in the period of crisis distinguish financially constrained and unconstrained firms, and find the effect in constrained firms only (e.g., Carbó-Valverde et al. 2016 and Lawrenz and Oberndorfer 2018). We focus on the real effect on a sales reduction.

By way of preview, we find similar findings between the samples for the GFC and the COVID-19. First of all, we find that for many firms, trade credit does not play the role of a

shock absorber, because the majority of our sample firms do not lengthen the duration of credit payment. From Analysis 1, a simple univariate analysis reveals that there is indeed a statistically significant difference in the fraction of firms that reduce the amount of purchases between firms that lengthen duration of trade credit and those that do not. However, the direction of the difference is at odds with our prior hypothesis. That is, firms that lengthen the duration are more, not less, likely to reduce the amount of purchases. The results after the PSM are qualitatively the same. Our results are inconsistent with the hypothesis that trade credit plays the role of a shock absorber.

Although Analysis 1 indicates that trade credit does not play the role of a shock absorber for many firms, Analysis 2 reveals that there are some determinants for the (infrequent) case where it plays that role. As for the variables for the suppliers, we find that the size of the suppliers, the firms' dependence on the suppliers, or the strength of the relationships with the suppliers do not affect the selection of the case of the shock absorber. These findings do not lend support to the deep pocket hypothesis. As for the variables for measures to banks, on the other hand, we find that trade credit plays the role of a shock absorber when a firm borrows from banks or relaxes terms of incumbent borrowing from banks.

On balance, our findings indicate that additional trade credit from suppliers does not play a significant role to cope with adverse shocks from the GFC or the COVID-19. First of all, we rarely observe the case where firms actually extend the period of credit payment. And among (the small number of) firms who did extend, the fraction of firms that did not reduce the amount of sales is not larger than the fraction of those who did not extend, and suppliers' characteristics do not affect the (small) likelihood that trade credit plays the role of a shock absorber.

On the other hand, we find that additional finance from banks promotes the (small) likelihood that trade credit plays the role of a shock absorber. Because we only use survey information, we cannot perfectly identify the causality relationship behind this finding. But, to

the extent that it indicates the promotion of the role of trade credit as a shock absorber due to the provision of support from banks, it implies that a policy measures to increase emergency lending, e.g., financial support or public credit guarantees, have a secondary effect. As a matter of fact, after the two crises the government of Japan implemented massive amount of policy measures to financially support firms, specifically low or zero interest rate direct lending by government-affiliated banks, subsidization of interest payments to private banks, and credit guarantees by the Credit Guarantee Corporations. Thus, for many firms, the decision regarding trade credit should have been made after the decision on the use of these easily available measures. Thus, these measures might have promoted the role of trade credit as a shock absorber, although the role is played for a limited number of firms.

Trade credit is one of the primary sources of finance for SMEs, and there are already many studies on it, especially on the determinants of its use, and on its substitutability or complementarity to bank loans.[1] Among this literature, this paper is closely related to studies on trade credit in a crisis period. Love, et al. (2007) examines the change in the amount of trade credit, and Norden et al. (2019) examines a relation between bank loans and trade credit in a crisis period, but they do not focus on the real effect of trade credit.

As studies on the real effect of trade credit in a crisis period, Carbó-Valverde et al. (2016) and Lawrenz and Oberndorfer (2018) examine the effect of the amounts (levels) of firms' accounts payable on investment.[2] They find that firms that have a larger amount of accounts payable invest more when they face borrowing constraint. They also find that this effect is pronounced in a period of crisis. These findings are inconsistent with our findings of a little

[1] As for the determinants of the use of trade credit, see, for example, Giannetti Burkart and Ellingsen (2011) and Klapper, Laeven and Rajan (2012) that sort out and test various theories on the determinants. As for the relation between trade credit and bank loans, see, for example, Danielson and Scott (2004), Bougheas et al. (2009), Atanasova and Wilson (2004), Molina and Preve (2012), and Lawrenz and Oberdorfer (2017) for empirical tests.

[2] Murfin and Njoroge (2015) also examine a real effect, but on investment in normal period.

role of trade credit as a shock absorber, especially for financially constrained firms.

Although it is hard to identify the reason for this inconsistency, it might be due to a difference in an analytical approach, or in the data sets including country-specific factors. We cannot completely rule out the possibility that the difference is due to country-specific factors. After the GFC and the COVID-19, the government of Japan implemented huge rescue packages, including massive provision of loans or credit guarantee by government-affiliated institutions. It might be that in Japan, firms could obtain sufficient funds from banks, and therefore did not have to rely on trade credit. However, our approach also differs from prior studies because we use granular information obtained from the corporate surveys, i.e., measures that firms actually took to cope with financial shocks, rather than the levels of trade credit and investments obtained from financial statements. Our focus on the amount of purchases makes sense because in practice, trade credit (accounts payable) is used to raise working capital, and its link with purchases is closer than its link with investment. At the least, our study calls for the need to clarify the mechanism behind the prior finding of the relation between trade credit and investment.

Analysis 2 is also related to empirical studies on the deep pocket hypothesis (Boissay and Gropp 2008, Garcia-Appendini and Montoriol-Garriga 2013, and Lawrenz and Oberdorfer 2017). These studies find that adverse shock is transmitted through a credit chain, but the transmission is mitigated if there is a supplier with a deep pocket. Although we do not directly analyze the transmission of shocks from accounts receivable to payable, our finding of no effect of supplier characteristics on the likelihood that firms lengthen the duration of payment period and reduce the amount of purchases is inconsistent with the deep pocket hypothesis. Again, however, this inconsistency might be due to differences in an analytical approach or in data. On balance, our findings call for more studies to dig deeper into the mechanisms behind the relation between trade credit and real outcome in the period of crisis.

The rest of the paper is composed as follows: Section 2 reviews related studies and explain our contribution. Section 3 introduces our data. In section 4, we establish our testable hypotheses and explain our empirical approaches and variables. Section 5 reports the results. Section 6 concludes the paper.

2. Related studies

2.1. Trade credit as an shock absorber

As explained in the introduction, the primary goal of this paper is to examine whether trade credit plays the role of a shock absorber for firms in crisis period. There are many studies on the effect of crisis on firms' financial constraint and their responses (e.g., Campello et al. 2010 and Campello et al. 2011), but only a limited number of studies focus on the role of trade credit (Love et al. 2007, Norden et al. 2019, Carbó-Valverde et al. 2016 and Lawrenz and Oberndorfer 2018). The present paper is closely related to these studies.[3]

First, Love et al. (2007) examine trade credit for the period of the Asian currency crisis in 1997, and find that just after the shock, trade credit increased on both sides of firms' balance sheet, which indicates that firms temporarily allowed postponement of payment with each other. But afterwards, the provision drastically decreased for several years, which suggests that trade credit did not compensate the decrease in bank loans. Different from this paper focusing on the amount of trade credit, we focus on the real effect of trade credit after the crisis using more detailed information from corporate surveys.

Norden et al. (2019) also examines the role of trade credit in a period of crisis using data of

[3] Relatedly, there are also studies to examine trade credit along business cycles or in response to monetary policy (e.g., Nielsen 2002, Choi and Kim 2005, Demiroglu et al. 2012).

SMEs in Europe at the period of the GFC. However, their focus is on the substitution between bank loans and trade credit. Their findings indicate that the extent of the substitution decreases during the financial crisis, and changes depending on SMEs' credit quality. Different from this study that focuses on the relation between the two financing sources, we focus on the real effect of trade credit.

As a study to examine a real effect of trade credit, our study is also related to Murfin and Njoroge (2015) that examine the effect of the terms of trade credit that small suppliers provide to large customers on the suppliers' investment. Comparing the cases of slower versus faster payment terms, they find that a slower one is associated with lower investment of the suppliers. However, this study examines the relation between the length of credit period and supplier's investment in normal times. We focus on the change in the length as a response to adverse shocks in the crisis period, and its effect on customers' reduction in sales. Also, our analysis is not limited to the case of large customers and small suppliers.

As a study to examine the real effect of trade credit in a crisis period, this paper is most closely related to Carbó-Valverde et al. (2016) and Lawrenz and Oberndorfer (2018). Carbó-Valverde et al. (2016) analyze the effect of trade credit (accounts payable) on investment (capital expenditure) of SMEs in Spain over the period 1994–2010, and find a positive effect for financially constrained firms during the GFC. Lawrenz and Oberndorfer (2019) also analyze the effect of trade credit (accounts payable, receivable, and net trade credit) on investment (capital expenditure) and ROA, and find a positive effect for small firms during the GFC. Different from these studies focusing on the effect on investment, we focus on a effect on a sales reduction in sales. Also, these studies examine the effect of the amounts (levels) of accounts payable, while we examine the effect of a relaxation (change) in trade credit terms as a response to adverse shocks that more appropriately capture the effect of the crisis.

The effect of the change in trade credit terms is the main focus in Barrot (2015), Breza and

Liberman (2017), and Barrot and Nanda (2017), but not for the period of crisis. Barrot (2015) investigates the effect of an exogenous change in credit terms by taking advantage of a regulation change for French trucking firms that shortens credit period. They find that firms' supply of trade credit (accounts receivable) decreased due to the change, and their default probability also decreased. Using data for one large supplier and its customers in Chile between 2006 and 2011, Breza and Liberman (2017) examine the effect of a regulatory change to shorten maturity of credit payment and find that the change reduced the likelihood of trade. Similarly, Barrot and Nanda (2017) examine the impact of shortening credit period by the U.S. government to small business contractors. They find a positive effect on the contractors' employment, although they also find a substantial crowd-out effect to reduce employment for other firms. Contrary to these studies that examine the effect of an exogenous shock in normal times to shorten credit period on suppliers' default or employment, we examine the association of lengthening payment period and the decrease in the amount of purchases in a crisis period.

2.2. Deep pocket

In this paper, we also analyze whether characteristics of firms' suppliers affect the extent of the association between the lengthening of payment periods and the reduction of purchases. As indicated in the introduction, such an analysis is closely related to the deep pocket hypothesis in the model of a credit chain (Meltzer 1960, Kiyotaki and Moore 1997). Empirical tests of this model find that an adverse shock is indeed transmitted through the credit chain (Boissay and Gropp 2008, Raddatz 2010, Jacobson and von Schedvin 2015).[4] And consistent with the deep pocket hypothesis, some studies find that the transmission is mitigated by a

[4] In studies on customer-supplier relationships or a supply chain, there are studies on the link of their financial conditions, but without focusing on trade credit (e.g., Itzkowitz 2013, 2015, Lian 2017).

supplier with a deep pocket (Boissay and Gropp 2008, Garcia-Appendini and Montoriol-Garriga 2013, Lawrenz and Oberdorfer 2017, and Murfin and Njoroge 2015). Our study is thus related to these studies.

Using data of French firms for the period 1998–2003, Boissay and Gropp (2008) find that the pass-on effect of adverse shocks from customers to suppliers is less likely to be observed when suppliers have more liquid asset, are large, and have lower likelihood of bankruptcy—a finding to support the deep pocket hypothesis. Using a matched sample of large U.S. firms and its customers from 2005 to 2010, Garcia-Appendini and Montoriol-Garriga (2013) find that although the large firms' provision of trade credit decreased after the crisis, it rather increased when the suppliers are cash-rich. By using data of SMEs and large firms in Germany from 2003 to 2010, Lawrenz and Oberdorfer (2017) obtain similar results for financially unconstrained suppliers. However, when they tease out the genuine size effect from financial conditions, they find that large firms do not redistribute credit to SMEs, which contradicts to the deep pocket hypothesis in terms of firm size. Different from these studies that focus on the provision of trade credit by suppliers with better financial conditions, we focus on whether the real effect of trade credit as a shock absorber depends on characteristics of suppliers.[5]

As for the real effect, Murfin and Njoroge (2015) introduced above find that the effect of slower payment terms by large customers to lower investment of their smaller suppliers is more pronounced for firms transacting with a financially constrained firms. But again, this paper focuses on the difference in payment terms in normal period and on investment, while we focus on the lengthening (change) of payment terms to respond to a crisis and on the reduction in sales amount.

[5] Using survey data from Japan after the GFC, Ogawa and Tanaka (2013) find that SMEs that incur demand shocks obtain help from suppliers. The likelihood of doing so does not vary with the length of customer-supplier relationships, but those with long relationships are less likely to obtain help from customers or banks.

3. Data

3.1. GFC survey

We use two samples of SMEs obtained from two corporate surveys conducted in Japan after two crises. The first sample is from a corporate survey the *Survey on Inter-firm and Firm-Bank Transactions during the Financial Crisis*, which was conducted in February 2009 by the Research Institute of Economy, Trade, and Industry (RIETI) (hereafter the GFC survey).[6] The GFC survey include questions on the shocks that firms suffered from, and the measures that they used to cope with the shocks after September 2008 when Lehman Brothers failed.[7] Note that in Japan, the GFC is not a financial but real shock imported through international trade, because the loss that financial institutions in Japan suffered was not huge, or concentrated to a few institutions only temporarily (see Uchida and Udell 2019).

The questionnaire of the GFC survey was mailed to 5,979 target firms, and 4,103 of them made responses (response rate of 68.6%).[8] Excluding firms that did not provide usable answers to the questionnaire, we obtain 4,095 firms. We further exclude firms that did not answer any of the questions about the measures to respond to the recession that we use for our main variables, or those for which any of the control variables used for the analysis below were not available. As a result of this selection process, our sample for the baseline analysis consists of

[6] Uesugi et al. (2009) report the details of the survey, the summary statistics, and the survey questionnaire. Papers using data from this survey include Tanaka and Ogawa (2013) and Tsuruta and Uchida (2019).
[7] Lehman's failure was a landmark event in Japan because adverse effects of the financial crisis in the U.S. and Europe was transmitted to Japan after the failure. The shocks due to the GFC are therefore commonly called the "Lehman shock" in Japan.
[8] The target firms of the GFC survey were the respondents to a survey conducted by the RIETI in 2008, and the target of this 2008 survey was 17,018 firms that were chosen from the firms that had responded to past government surveys compiled by the Small and Medium Enterprise Agency of the Government of Japan. Among these firms, 6,124 made response (response rate of 36%).

3,469 firms. The number of observations is smaller in the regression analyses due to the non-availability of the dependent variables or the main independent variables.

3.2. COVID-19 survey

The second source of our data is the *Survey on the Status of Firms under the COVID-19 Pandemic* conducted in Japan in November 2020 by the RIETI (hereafter the COVID survey). The COVID survey aims to capture effects of the spread of the COVID-19 on corporate activities.[9] This survey includes questions about the shocks that firms incurred, and the measures to cope with the shocks during the COVID-19 pandemic up to the survey date. As shown in Figure 1, November 2020 was at the beginning of the third wave of the infections in Japan.

<<<Insert Figure 1 about here >>>

The questionnaire of this survey was mailed to 20,000 target firms, and 4,718 of them made responses (response rate of 23.8%).[10] Excluding firms that did not provide important information including industry, we have 4,693 firms as our starting point. We eliminate firms that did not provide important information including number of employee, year of

[9] Uesugi et al. (2021) report the details of the survey, the summary statistics, and the survey questionnaire.
[10] The target firms of the COVID-19 survey is the 8,310 respondents to three predecessor surveys by the RIETI (the GFC survey, its 2008 predecessor survey, and/or the Survey on the Aftermath of the SME Financing Facilitation Act conducted in 2014), plus 11,690 firms newly added, all incorporated businesses (no sole proprietorships). The 11,690 firms were chosen from the corporate database of Tokyo Shoko Research, one of the largest corporate credit information providers, so as for the resulting 20,000 firms to have the same industry distribution to that of the 2016 Economic Census for Business Activity (Ministry of Internal Affairs and Communications and Ministry of Economy, Trade and Industry), the most comprehensive corporate statistics in Japan, and to have the same employee-size distribution to that of the 8,310 respondents. See Uesugi et al. (2015) for the details of the SME Finance Facilitation Law survey.

establishment, credit score, and the amount of borrowing. We further eliminate firms that did not answer any of the questions about the measures to respond to the recession that we use for our main variables. As a result of this selection process, our sample for the baseline analysis consists of 3,767 firms, although the number of observations for regression analyses becomes smaller due to missing observations for some variables.

4. Methodology

4.1. Main hypothesis and main variables

Our main research question is whether trade credit plays the role of a shock absorber. More specifically, we examine whether firms that extend the period of credit payments do not reduce the amount of purchases. However, it is not easy to empirically answer this question, because the above questions implicitly presume a causal relation from the extension of credit period to the non-reduction of purchase amounts. In reality, firms might take various measures to cope with adverse shocks in an ad hoc manner, and causal relationships among them might not be clear.

To overcome this challenge, the GFC and the COVID surveys focus on the outcome, i.e., ask measures that firms actually took, without asking their sequence. And we use this information to answer the above question. For the question on how firms responded to the crisis and the subsequent recession, the two surveys list measures that firms can potentially take in relation to their customers, suppliers, and banks (multiple answers allowed), as options to choose.

Among such options, we focus on the options on measures to suppliers. The options listed in the GFC survey include: “1. Reduced the quantity of purchases;” “3. Lengthened the duration

of accounts payable;" "4. Lengthened the duration of promissory bills payable;" and "5. Increased the ratio of the amount of payments by accounts payable or promissory bills to the total amount of payments."[11,12] We define a variable REDUCE_PURCHASE to take the value of one if the firm choose option 1, and LENGHEN_TC to take the value of one if the firm choose at least one of options 3-5. In the COVID survey, the options presented to firms are almost the same (with some differences, e.g., options 3 and 4 are integrated), and we can obtain the same information to define the two variables.

As our main hypothesis to test using these variables, we establish the following testable hypothesis:

Hypothesis 1: The fraction of firms that reduced the amount of purchases is smaller among the firms that extended the period of credit payments than among those that did not.

4.2. Analysis 1: Analysis of trade credit as a shock absorber

4.2.1. Simple univariate analysis

To test Hypothesis 1, we analyze the distribution or correlation of the two variables, which we label Analysis 1. We conduct two such analyses. The first analysis, Analysis 1-1, directly test the hypothesis by comparing the fraction of firms with REDUCE_PURCHASE = 0 among the firms with LENGTHEN_TC = 1 and the same fraction among the firms with LENGTHEN_TC = 0. Hypothesis 1 predicts that the former is higher than the latter, or

[11] Options 3 and 4 are separated because there are two commonly used methods to provide trade credit in Japan, one through ordinary accounts payable and the other though paper-based promissory bills. From a viewpoint of economic functions, they are essentially the same.

[12] The other options to choose on measures to suppliers are: "2. Decreased the price of goods to be purchased," "6. Explained to suppliers the difficulty of your company's situation," and "7. Did not take any particular measure."

equivalently, the mean of REDUCE_PURCHASE is smaller for firms with LENGTHEN_TC = 1 than for those with LENGTHEN_TC = 0. We thus conduct a t-test of the difference in means (or fraction) of REDUCE_PURCHASE between firms with LENGTHEN_TC = 0 and with 1.

We also test Hypothesis 1 by checking the joint distribution of REDUCE_PURCHASE and LENGTHEN_TC. The hypothesis predicts that firms will either lengthen the payment period and do not reduce the amount of purchases ("LENGTHEN_TC = 1 and REDUCE_PURCHASE = 0"), or do not lengthen the period and (have to) reduce the amount ("LENGTHEN_TC = 0 and REDUCE_PURCHASE = 1"). Also, the hypothesis predicts that we do not observe firms with "LENGTHEN_TC = 0 and REDUCE_PURCHASE = 0" or "LENGTHEN_TC = 1 and REDUCE_PURCHASE = 1." We thus check whether these are the cases by using a cross tabulation, and conduct a Chi-squared test the independence of the two variables. We label this Analysis 1-2.

4.2.2. Univariate analysis after propensity score matching

However, simple analyses like Analyses 1-1 and 1-2 might suffer from a drawback, because they do not take into account heterogeneity among firms. For example, firms do not have to lengthen the period of credit payment or reduce the amount of purchases if they do not suffer any adverse shocks, or if they do suffer the shocks but can take other (more effective) measures. In such cases, firms would neither lengthen credit period nor reduce the amount of purchases, and so it might be natural to observe many firms with LENGTHEN_TC = REDUCE_PURCHASE = 0. Also, if firms suffer severe damages, they might take both measures, so we might also observe firms with LENGTHEN_TC = REDUCE_PURCHASE = 1.

To consider heterogeneity of firms, we control for firm characteristics and other factors by using a propensity score matching (PSM). Specifically, we run a probit model regression, where LENGTHEN_TC is the dependent variable and firm characteristics or other factors are independent variable, and calculate the propensity score. Using the score, we construct an artificial control group of firms with LENGTHEN_TC = 0 that are similar to those with LENGTHEN_TC = 1. Using this control group and the treatment group with LENGTHEN_TC = 1, we augment Analyses 1-1 and 1-2. That is, we compare the fraction of firms with REDUCE_PURCHASE = 0 between the two groups (Analysis 1-1-PSM) and check the joint distribution of the two variables in a cross tabulation using the matched sample (Analysis 1-2-PSM) .

4.3. Analysis 2: Analysis on the determinants of shock absorber

Analysis 1 examines *whether* trade credit plays the role of a shock absorber, and essentially it does so by testing whether we frequently observe the case where (LENGTHEN_TC, REDUCE_PURCHASE) = (1, 0) as opposed to the other cases. However, irrespective of how frequent we observe the case, it is also informative to know *when*, or *under what circumstances* it is the case. We thus analyze the determinants of trade credit as a shock absorber.

In this analysis, we run a multinomial regression on the joint determination of LENGTHEN_TC and REDUCE_PURCHASE, which we label Analysis 2. Specifically, we interact LENGTHEN_TC and REDUCE_PURCHASE and construct a multinomial variable to indicate these four cases: (LENGTHEN_TC, REDUCE_PURCHASE) = (0, 0), (1, 0), (0, 1) and (1, 1). Using this multinomial variable as a dependent variable, we estimate a multinomial logit model for the joint determination of LENGTHEN_TC and REDUCE_PURCHASE. This estimation allows us to identify factors (independent variables) that contribute to the selection

of the above four cases, and we put our primary focus on factors that contribute to the selection of the case (1, 0).

4.4. Deep pocket

We use many variables as variables to calculate the propensity score for Analyses 1 and as proxies for the determinants of trade credit as a shock absorber in the multinomial regression in Analysis 2. Among such variables, we put our primary focus on heterogeneity in terms of characteristics of firms' suppliers. Whether trade credit plays a role of a shock absorber depends not only on factors of the firms that obtain credit (debtors) but also on those that provide it (creditors, or suppliers). The deep pocket hypothesis introduced above predicts that only affordable suppliers can provide emergency credit that could play the role of a shock absorber. We thus test the following hypothesis:

Hypothesis 2 (deep pocket): The case where firms lengthen the period of credit payment and do not reduce the amount of purchases is observed only for suppliers with specific characteristics.

To test this hypothesis, we use three variables. The variable S_LARGE is a dummy variable to indicate that the largest supplier is large, or its number of employee is larger than 300.[13,14] The variable S_PURCHASE is the ratio of the amount of purchases from the largest supplier to the total amount of purchases. The variable S_RELATION is the duration (years) of

[13] We do not use a continuous variable for the number of employees because we only have categorical information.

[14] SMEs under the SME Basic Act in Japan are defined as firms with 300 million yen of capital stock or less and/or 300 or fewer regular employees.

transactional relationships with the largest supplier. These variables are respectively proxies for suppliers that can absorb an adverse shock, those that the firms highly depend on, and those that have strong relationships with the firms and might have better information on their creditworthiness.

To the extent that such suppliers play the role of a deep pocket, we expect that these variables have positive effects on the selection of (LENGTHEN_TC, REDUCE_PURCHASE) = (1, 0) in the multinomial regression. This is our test of Hypothesis 2. On the other hand, even if the suppliers accept the lengthening of credit period, firms might need to reduce the amount of sales if a shock is sufficiently large. In this case, these variables have a positive effect on the selection of (LENGTHEN_TC, REDUCE_PURCHASE) = (1, 1). However, firms that depend too much on specific suppliers might rather have small bargaining power over the firms, so S_PURCHASE and S_RELATION might also contribute to the selection of (LENGTHEN_TC, REDUCE_PURCHASE) = (0, 1) or (0, 0) in the multivariate model.

4.5. Bank loans and financial constraint

We also use indicators for measures that the firms take from banks to account for firm heterogeneity, because firms that could take other measures, might not have to extend payment period or reduce the amount of purchases. Among such measures, measures to banks are of particular importance. As mentioned in section 2.1, there are many studies on the substitution or complementarity of bank loans and trade credit. Among such studies, those focusing on the role of trade credit in shock periods distinguish financially constrained and unconstrained firms and find the role in constrained firms only (e.g., Carbó-Valverde et al. 2016 and Lawrenz and Oberndorfer 2018). We thus establish the following hypothesis:

Hypothesis 3 (bank loans and financial constraint): The case where firms lengthen the period of credit payment and do not reduce the amount of purchases is observed only for firms that did not borrow from banks to cope with adverse shocks.

We use the following dummies for emergency borrowing from banks as measures that firms actually took to cope with adverse shocks: M_BANK1 for borrowing from banks (the largest, the second-largest, and/or other private or government affiliated-banks) with or without guarantee by the Credit Guarantee Corporations; M_BANK2 for relaxation of terms of incumbent borrowing from banks (extension of loan maturity by the largest, the second-largest, and/or other banks).[15] These dummies indicate the presence of financial support from banks, and should contribute to reduce the need for trade credit to play the role of a shock absorber. Thus under Hypothesis3, we expect that these variables have negative effects on the selection of (LENGTHEN_TC, REDUCE_PURCHASE) = (1, 0) in the multinomial regression.

When we interpret the results for M_BANK1 and M_BANK2, however, a caveat is in order. Similar to the two measures to suppliers that are of our primary interest, these measures to banks are also constructed from the survey questions on the outcome, or the measures they actually took, and we do not know their sequence. Due to this reason, we cannot interpret the results from a causality viewpoint. For example, a positive effect of these variables indicates that these measure to banks promotes the use of the measure to suppliers, or vice versa. On the other hand, however, it is more likely that the causality goes from bank borrowing to trade credit, because of the massive amount of financial support for firms through policy measures implemented by the government of Japan. The government provided low interest rate direct lending by government-affiliated banks, subsidization of interest payments to private banks,

[15] The Credit Guarantee Corporations in Japan are government-affiliated institutions to provide corporate credit guarantees to firms for policy purposes.

and credit guarantees by the Credit Guarantee Corporations, and firms should have used these cheap borrowing first before resorting to trade credit. And even if the direction is opposite, a finding of the negative effect of these variables at least indicate that bank loans and trade credit are substitute to each other.

As for banks, we also use the natural logarithm of B_RELATION that represents the duration (years) of lending relationships between the firms and their largest lenders. Since the seminal studies by Petersen and Rajan (1994) and Berger Udell (1995), the duration is frequently used in the literature on relationship lending as a proxy for strong bank-firm relationships, through which banks accumulate soft information and produce benefits. We use B_RELATION to capture any beneficial effect from banks with close relationships, other than that captured by the two actually taken measures.

4.6. Other independent variables

We also use other variables as independent variables. First, firms that (need to) take measures to cope with adverse shocks must be firms that actually suffer from the shocks. We thus construct the following dummy variables from the survey to indicate that the firms suffer shocks: SHK_CUS_REAL1 for real shocks from customers (their business slump or bankruptcy or increase in unrecoverable claims); SHK_CUS_REAL2 for real shocks on sales to customers (reduction in sales or sales prices); SHK_CUS_FIN for financial shocks due to extension of credit period to customers (lengthening of period of accounts receivable or promissory bills, or a decrease in payment by cash); and SHK_SUP_REAL for real shocks from suppliers (their business slump or bankruptcy).[16] Using these variables, we control for firms

[16] See Table 1 for more precise definitions of these variables.

without suffering from adverse shocks, which are likely to choose (LENGTHEN_TC, REDUCE_PURCHASE) = (0, 0). SHK_SUP_REAL might also indicate the fact that suppliers do not have a deep pocket.

Finally, we use variables for firm characteristics: the natural logarithm of the number of employees (EMP), the natural logarithm of firm age (AGE), firms' credit score (SCORE) provided by the TSR, and the natural logarithm of the amount of borrowing (BORROW). We also use dummy variables for industry fixed effects. These variables capture firms' ex ante characteristics.

4.7. Descriptive statistics

Table 1 reports descriptive statistics for the above variables for the GFC sample (row A) and for the COVID sample (row B). In the GFC sample, the fraction of firms that lengthened the credit period is about 3.5%, and that of firms that reduced the amount of purchases is 17.6%. In the COVID sample, only 1.4% of the sample firms lengthen credit period, and only 6.0% of them reduce the amount of purchases. As far as these variables are concerned, the shocks from the GFC were greater than those from the COVID-19 (at least up to the survey period of the COVID survey). However, the lengthening is not a commonly used measure in both samples.

<<<Insert Table 1 about here>>>

As for the variables for suppliers, 44.2% of the firms in the GFC sample transact with suppliers that are large in size (with more than 300 employees). The dependence on the largest suppliers in terms of the fraction of purchases is of 35.0% on average, and the duration of transactional relationships with the suppliers is on average 27.4 years. In the COVID sample,

39.5% of the firms transact with large suppliers, the fraction of purchases from the suppliers is on average 36.6%, and the duration of transactional relationships with them is on average 29.4 years. These characteristics are comparable between the two samples.

Turning to the variables for firm characteristics, firms in the GFC sample have 134 employees and are 39 years old on average. The amount of borrowing is on average JPY 2.9 billion. Compared with these firms, firms in the COVID sample are on average smaller in size, older, and borrow a smaller amount.

As for the shock incurred, the most common shock that firms in the GFC sample incurred is real shocks on sales to customers (77.5%), and the next most is a real shock from customers (32.2%). Compared with these shocks, firms do not frequently suffer financial shocks from customers or real shocks from suppliers. In the COVID sample, the most common shock is also real shocks on sales to customers, but the fraction of firms experiencing the shock is 53.7%. The next most common shock is a real shock from customers (10.5%), and financial shocks from customers or real shocks from suppliers are rarely observed. On balance, firms in the COVID sample suffer less from shocks than those in the GFC sample, but their relative frequencies are qualitatively the same.

As for the measures to banks, 51.8% of the sample firms in the GFC sample borrow from banks (the largest, the second-largest, and/or other private or government affiliated-banks), but rarely obtain relaxation of terms for incumbent borrowing from banks (extension of loan maturity by the largest, the second-largest, and/or other banks). The average years of relationships with the largest banks is 25.98 years. In the COVID sample, firms that borrow from banks consist of about 40% of the sample, which is smaller than that in the GFC sample. The years of relationships are slightly longer.

Finally, Table 2 shows the frequency and percentage distribution for the number of observations by industry. In both samples, the fraction of manufacturing firms is the largest,

followed by construction. The distributions are similar across the two samples, but the fraction of wholesale firms is larger in the GFC sample than in the COVID sample.

<<<Insert Table 2 about here >>>

5. Results

5.1. Results for Analysis 1

Tables 3 and 4 report the results for Analysis 1, They compare the distribution of REDUCE_PURCHASE depending on the value of LENGTHEN_TC for the GFC sample (Table 3) and the COVID sample (Table 4). In each table, panel A shows the fractions of firms with REDUCE_PURCHASE = 1 (its means) for the sub-sample with LENGTHEN_TC = 0 and 1, together with the differences in the fractions and the statistical significance of the differences based on t-tests of difference in means (fractions). Panel B shows the cross tabulation of the two variables, and the results for Chi-squared tests for independence of the two variables. In both panels, row (1) reports the results using the whole sample, and rows (2) report the results after propensity score matching. The results for the estimations of probit models to calculate the propensity score are in Appendix tables A1 (GFC sample) and A2 (COVID sample).

<<<Insert Table 3 about here >>>

From Panel A of Table 3, we find on row (1) that there is a difference in the fraction of firms that reduce the amount of purchases depending on whether they lengthen duration of trade credit. Also, the difference is statistically significant. However, the direction of the difference is at odds with Hypothesis 1. It indicates that firms that lengthened the duration are *more*, not

less, likely to reduce the amount of purchases. Because this is a comparison without any conditioning, the results after propensity score matching are more important. The results in row (2) indicates that the fraction of firms with REDUCE_PURCHASE = 1 is again larger when LENGTHEN_TC = 1 than when it is zero. The difference is statistically significant.

Cross tabulation in Panel B of Table 3 provide us with more detailed information. Before the matching (rows (1)), LENGTHEN_TC equals zero for the majority of firms, that is, most firms do not lengthen the period of credit payment. And among such firms, the majority does not reduce the amount of purchases. This means that most of the firms neither lengthen credit period nor reduce the amount of purchases. The fraction of firms that reduce the amount of purchases is larger among firms with LENGTHEN_TC = 1, but they are minority. The Chi-squared test result indicates that the distributions of the two variables are dependent in a statistically significant manner, but again, the direction of the dependence is opposite to the one predicted by Hypothesis 1. The difference in the likelihoods of REDUCE_PURCHASE = 1 between firms with LENGTHEN_TC = 0 and = 1 are smaller, and are now comparable, after the propensity score matching (rows (2)), and the Chi-squared test do not reject the null hypothesis that the two variables are independent. However, these results are still inconsistent with Hypothesis 1.

The results for the COVID sample in Table 4 are mostly the same. In Panel A, the fraction of firms that reduced the amount of purchases is larger when LENGTHEN_TC = 1 than when = 0 in both rows (1) and (2). The difference in the fraction between the two columns is statistically significant in both rows (1) and (2). But again, the signs of the differences are the opposite to what Hypothesis 1 predicts. Also, the results from the cross tabulation in Panel B are consistent with those in Panel B of Table 3, with one difference in the result for the independence of the two variables in rows (2), which are now statistically significant, but in the opposite direction to what Hypothesis 1 predicts. The shock firms suffered might have been

large enough, and they might have needed to reduce the amount of purchases as well as to lengthen period of credit payment.

<<<Insert Table 4 about here >>>

5.2. Results for Analysis 2

The results for Analysis 2 are shown in Tables 5 and 6. Table 5 is for the GFC sample and Table 6 is for the COVID one. In each table, Panel A shows the estimation results, and Panel B shows the marginal effects of selected variables. Columns [1] in these tables show the results of a parsimonious specification without using the variables for suppliers, and columns [2] show those of a full specification with using them. We report both results to check the robustness of the results because the use of the variables for suppliers reduces a large number of observations. The results in columns [1] and [2] are qualitatively very similar in both tables, so we focus on the results in columns [2]. The columns [1] and [2] consist of sub-columns (i) through (iv), which indicates the selection of the four possible cases for REDUCE_PURCHASE and LENGTHEN_TC indicated by the multinomial dependent variable. We set the case where both variables take the value of zero (column (i)) as the default case. Thus, the coefficients in columns (ii) through (iv) indicate the contribution of the independent variables to the choice of the corresponding cases relative to the case indicated in column (i).

<<< Insert Table 5 about here >>>

<<< Insert Table 6 about here >>>

5.2.1. Results for supplier characteristics

The results of our primary interest are those in columns (ii) that show when, or under what conditions trade credit plays the role of a shock absorber (LENGTHEN_TC = 1 and REDUCE_PURCHASE = 0). Among the results in column (ii), we are especially interested in the results for the variables for measures to suppliers and banks because they are to test Hypotheses 2 and 3.

As for the three measures to suppliers, we first find that in the GFC sample, they have no statistically significant effects. The size of the suppliers, the dependence on the suppliers, or the strength of the relationships with the suppliers do not affect the likelihood that firms lengthen the period of credit payment and do not reduce the amount of purchases as measures to cope with adverse shocks. The results are almost the same for the COVID sample (Table 6) as well. The three variables do not have a statistically significant effect on the selection of case (ii), and the marginal effects are also insignificant. At least as far as these variables are concerned, supplier characteristics do not increase the likelihood that trade credit plays the role of a shock absorber. Thus, our findings do not lend support to the deep pocket hypothesis of Hypothesis 2.

We also find that supplier characteristics do not affect the selection of the other cases as well. In columns (iii) and (iv) of Table 5, the three variables for suppliers have no statistically significant coefficients or marginal effects in all columns. At the time of the Global Financial Crisis, suppliers' characteristics do not matter for whether firms take measures to cope with the shocks in relation to their suppliers.

In the case of the COVID-19 shock, we find a negative effect of S_PURCHASE on the choice of (REDUCE_PURCHASE, LENGTHEN_TC) = (1, 0) (column (iii) of Table 6). As shown in Panel B, this negative effect is a mirror image of its positive effect on the choice of (0, 0). This result indicates that firms that rely much of their purchases on largest suppliers do not tend to reduce the amount of purchases (without lengthening the period of credit payment)

that are most likely from the largest suppliers.

5.2.2. Results for banks

As for the variables for measures to banks, we find in column (ii) of Table 5 that M_BANK1 and M_BANK2 have positive and statistically significant coefficients. In the case of the GFC, trade credit plays the role of a shock absorber when a firm borrows from banks or relaxes terms of incumbent borrowing from banks. The results are somewhat different in Table 6, and in its column (ii), although M_BANK_2 has a positive and statistically significant coefficient, the coefficient for M_BANK1 is negative, and loses its statistical significance. In the case of the COVID-19 crisis, whether firms obtain new borrowing from banks do not matter for whether trade credit plays the role of a shock absorber.

Although the results are qualitatively different, these results on balance indicate that the role of trade credit as a shock absorber takes place when firms obtain financial support from banks. This finding is, however, inconsistent with Hypothesis 3, because it predicts that trade credit plays the role only for financially constrained borrowers. We rather find that trade credit does not play the role of a shock absorber when firms do not obtain additional finance from banks.

Our finding has some policy implication. To the extent that it reflects the fact that the provision of support from banks invites suppliers' extension of trade credit, a policy to promote emergency lending by banks will have a side effect to promote the role of trade credit from suppliers as a shock absorber. However, as mentioned in subsection 3.2.5, we cannot necessarily interpret the results in Analysis 2 as a causal relation, because we have no information on the sequence in which these measures were taken. However, regardless of which scenario holds, our results indicate that trade credit as a shock absorber might be complement with financial

support from banks.

This finding is inconsistent with prior findings (e.g., Carbó-Valverde et al. 2016 and Lawrenz and Oberndorfer 2018) that indicate the substitutability of bank loans and trade credit. Although it is hard to identify the reason for this inconsistency, it might be due to a difference in the data sets including country-specific factors, or in an analytical approach. We cannot completely rule out the possibility that the results from the prior studies and ours are different due to country specific factors. After the GFC and the COVID-19, the government of Japan implemented huge rescue packages, including provision of loans by government-affiliated banks and credit guarantees by the Credit Guarantee Corporations (another government-affiliated institutions) in each prefecture, and support interest payments of incumbent loans. Anecdotal evidence that the number of corporate bankruptcies did not surge at early periods of the crises suggests that firms could obtain sufficient funds from banks, and did not have to rely on trade credit as the last resort. Our finding from Analysis 1 supports this view as well. In Table 1, the means of LENGTHEN_TC or REDUCE_PURCHASE are respectively 0.035 and 0.176 for the GFC sample and 0.014 and 0.060 for the COVID sample, which are significantly smaller than the mean of M_BANK1 of 0.518 for the GFC sample and 0.402 for the COVID sample. As far as our two samples are concerned, it is not suppliers but banks that provide emergency finance to firms. In this sense, trade credit does not play a significant role as a measure to cope with adverse shocks.

However, we cannot completely rule out the possibility that the differences in the results stem from differences in the analytical approaches. The most significant difference between the prior studies and ours is our granular information obtained from the corporate surveys. Most importantly, instead of using the amount of trade credit and investments from financial statements, we use information on whether firms extended of periods of credit payments and whether they reduced the amount of purchases as measures that firms actually took to cope with

adverse shocks from the two crises. Our focus on purchases as a real outcome makes sense, because trade credit in practice is used to raise working capital, and its link with purchases is closer than its link with investment. Because it is not very clear under what mechanisms trade credit affects investments, our findings call for more studies to dig deeper into the mechanisms behind the prior findings.

5.2.3. Results for shocks and other measures

Turning to the variables other than those related to Hypotheses 2 and 3, we find in column (ii) that some variables have significant effects on the selection of the outcome of the shock absorber (LENGTHEN_TC = 1 and REDUCE_PURCHASE = 0). In Table 5, SHK_CUS _FIN has a positive and statistically significant coefficient and credit score has a negative one. These results indicate that firms' suppliers might provide additional credit to play the role of a shock absorber to firms that suffer customers' default, or to less creditworthy firms.

The results are somewhat different in column (ii) in Table 6. Again, we find that SHK_CUS_FIN has a positive and statistically significant coefficients, and instead SHK_CUS_REAL2 turned positive and significant. In the case of the COVID-19 crisis, trade credit played the role of a shock absorber for firms that suffered real shocks on sales to customers (reduction in sales or sales prices)

5.2.4. Other results

Let us finally discuss some notable results in the columns other than column (ii). In Table 5, business slump or bankruptcy of customers (SHK_CUS_REAL1), real shock on sales to customers (SHK_CUS_REAL2), or real shock of business slump or bankruptcy of suppliers

(SHK_SUP_REAL) contribute to the selection of REDUCE_PURCHASES = 1 and LENGTHEN_TC = 0. The latter two variables also have positive and statistically significant effects in Table 5 for the COVID sample. These findings indicate that firms that suffer real shocks tend to take a real measure to suppliers. Also, SHK_CUS _FIN has a positive and statistically significant coefficient in column (iv) in both Tables 5 and 6. Together with its positive effect in column (ii), firms that suffer a financial shock from customers are more likely to lengthen payment terms. Altogether, these findings are consistent with the finding in Ogawa and Tanaka (2013) of the correspondence between the types (real versus financial) of shocks and types of measures.

As for the effect of M_BANK1 and M_BANK2, there are differences between Tables 5 and 6. Both variables have positive and significant effect in columns (ii) through (iv) in Table 5, but only M_BANK2 has such an effect in columns (ii) and (iv) in Table 6. Support from banks are associated with measures to suppliers, but the manner this association manifest itself is different between the two crises.

6. Conclusion

In this paper, we examined whether trade credit contributes to absorb adverse shocks to firms and plays the role of a shock absorber. By using data of SMEs obtained from two corporate surveys after the Global Financial Crisis and the COVID-19 shocks, we tested whether the relaxation of trade credit terms contributes to hold back the level of real activities in terms of the reduction in the amount of purchases.

From our analysis, we do not find that firms that postponed the payment are less likely to reduce the amount of purchases, which indicates that trade credit does not contribute to absorb adverse shocks. We also find that the (small) likelihood that trade credit plays the role of a

shock absorber is neither increased nor decreased by factors of its providers (i.e., suppliers), but emergency borrowing from banks and trade credit increases the likelihood. These findings are not consistent with findings in prior studies that take different analytical approach and use different data to clarify the real effect of trade credit and its relation to bank loans in a period of crisis. On balance, our findings call for more studies to reconcile these different findings by digging deeper into the mechanisms behind the relation between trade credit and real outcome of firms in the period of crisis.

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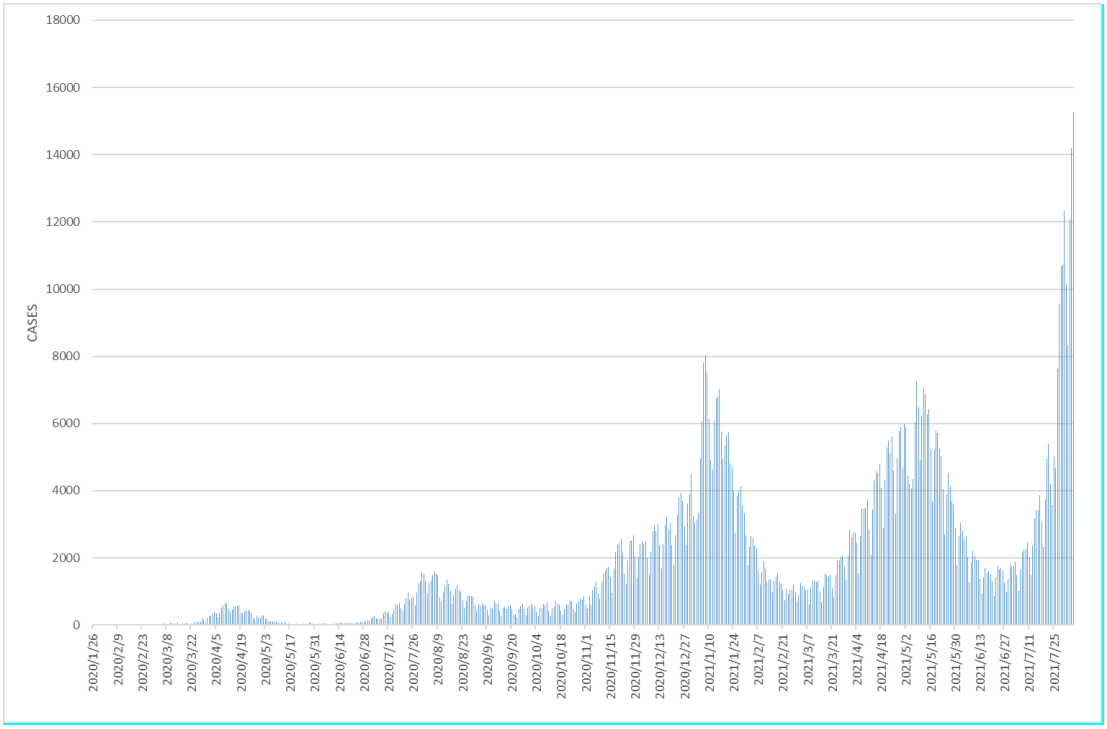
Figure 1 Newly reported cases for COVID-19 infections



Source: Made by the authors using data available from the website coronavirus "Situation report," of the Ministry of Health, Labor and Welfare (https://www.mhlw.go.jp/stf/covid-19/kokunainohasseijoukyou_00006.html, accessed on August 6, 2021).

Table 1 Descriptive statistics

This table shows the descriptive statistics for the variables we use in this paper.

		(A) GFC Survey						(B) COVID-19 Survey					
Variable	Definition	Obs	Mean	Median	Std. Dev.	Min	Max	Obs	Mean	Median	Std. Dev.	Min	Max
Main variables													
LENGTHEN_TC	Dummy = 1 if the firm lengthened the sight [= duration] of accounts or promissory bills payables for the payment to any supplier or the firm increased the ratio of payments by promissory bills or on account to total payments to any supplier to cope	3355	0.035	0.000	0.183	0.000	1.000	3767	0.014	0.000	0.119	0.000	1.000
REDUCE_PURCHASE	Dummy = 1 if the firm reduced the quantity of purchases from any supplier to cope with the recession	3355	0.176	0.000	0.381	0.000	1.000	3767	0.060	0.000	0.238	0.000	1.000
Variables for suppliers													
S_LARGE	Dummy= 1 if the largest supplier's number of employee is larger than 300	2106	0.442	0.000	0.497	0.000	1.000	2580	0.395	0.000	0.489	0.000	1.000
S_PURCHASE	The ratio of the amount of purchases from the largest supplier to the total amount of purchases.	2106	0.350	0.284	0.250	0.000	1.000	2580	0.366	0.300	0.271	0.000	1.000
S_RELATION	Duration (years) of transactional relationships with the largest supplier	2106	27.414	27.500	15.456	1.000	103.0	2580	29.431	28.000	17.679	0.000	130.0
Variables for shocks													
SHK_CUS _REAL1	Dummy for real shocks from customers (their business slump or bankruptcy) (GFC) Dummy= 1 if the firm suffered a shock of business slump or failure of customers or an increase in uncollectable claims (COVID) Dummy= 1 if the firm suffered a shock of business slump of customers	3355	0.322	0.000	0.467	0.000	1.000	3767	0.105	0.000	0.307	0.000	1.000
SHK_CUS _REAL2	Dummy for real shocks on sales to customers (reduction in sales or sales prices) (GFC) Dummy= 1 if the firm suffered a shock of a decrease in sales or a decrease in sales prices (COVID) Dummy= 1 if the firm suffered cancellation of sales to firms, was asked to ease terms of sales to firms, and suffered a decrease in sales to consumers	3355	0.775	1.000	0.418	0.000	1.000	3767	0.537	1.000	0.499	0.000	1.000
SHK_CUS _FIN	Dummy for financial shocks from customers' default (increase in unrecoverable claims) (GFC) Dummy= 1 if the firm suffered a shock of an extension of the period of acccounts receivables or promissory bills receivables, or a decrease in sales by cash	3355	0.132	0.000	0.338	0.000	1.000	3767	0.050	0.000	0.217	0.000	1.000
SHK_SUP_REAL	Dummy for financial shocks due to extension of credit period to customers (lengthening of period of accounts receivable or promissory bills, or a decrease in payment by cash) (GFC) Dummy= 1 if the firm suffered a shock of business slump or failure of its main or other suppliers	3355	0.105	0.000	0.306	0.000	1.000	3767	0.042	0.000	0.200	0.000	1.000
Variables for measures to banks													
M_BANK1	Dummy= 1 if the firm borrow from banks (the largest, the second-largest, and/or other private or government affliated-banks) with or without guarantee by the Credit	3355	0.518	1.000	0.500	0.000	1.000	3767	0.402	0.000	0.490	0.000	1.000
M_BANK2	Dummy= 1 if the firm obtained relaxation of terms of incumbent borrowing from banks (extension of loan maturity by the largest, the second-largest, and/or other	3355	0.038	0.000	0.192	0.000	1.000	3767	0.094	0.000	0.292	0.000	1.000
B_RELATION	Duration (years) of lending relationships between the firms and their largest lenders	2106	25.984	25.000	18.956	0.000	207.000	2580	29.431	28.000	17.679	0.000	130.000
Variables for firm characteristics													
EMP	Number of employee before the shock	3355	133.802	28.000	829.4	1.000	36123.0	3767	66.321	24.000	254.5	1.000	8507.0
AGE	Firms' age (years)	3355	39.451	39.000	17.4	8.000	120.0	3767	43.063	44.000	19.2	1.000	124.0
SCORE	Firms' score before the shock	3355	54.619	54.000	6.8	39.000	87.0	3767	51.326	51.000	6.7	30.000	79.0
BORROW	Firms' bank borrowings before the shock (million yen)	3355	2926.131	180.000	37814.8	0.000	1792273.0	3767	1052.600	87.000	14172.1	0.000	560486.0

Table 2 Distribution of observations by industries

This table shows the frequency and percentage distribution for the number of observations by industry.

	(A) GFC Survey		(B) COVID-19 Survey	
	No. of obs.	(%)	No. of obs.	(%)
Construction	772	23.01	796	21.13
Manufacturing	827	24.65	882	23.41
Information and Communications	89	2.65	91	2.42
Transportations	119	3.55	83	2.2
Wholesales	758	22.59	280	7.43
Retail	334	9.96	220	5.84
Real Estate	91	2.71	75	1.99
Restaurants	5	0.15	29	0.77
Other services	36	1.07	222	5.89
Others	324	9.66	447	11.87
(Unknown)			642	17.04
Total	3355	100	3767	100

Table 3 Fraction and cross-tabulation (GFC sample)

This table shows the average value of REDUCE_PURCHASE by LENGTHEN_TC and the cross-tabulations for LENGTHEN_TC and REDUCE_PURCHASE. *** denotes significance at the 1% level.

Panel A: Fraction

	LENGTHEN_TC = 0	LENGTHEN_TC = 1	Difference
(1) Whole sample	0.170	0.342	0.171 ***
(2) PSM	0.179	0.359	0.179 ***

Panel B: Cross-tabulation

(1) Whole sample

	LENGTHEN_TC = 0	LENGTHEN_TC = 1	Total
REDUCE_PURCHASE= 0	2686	77	2763
	(80.06%)	(2.30%)	
REDUCE_PURCHASE= 1	552	40	592
	(16.45%)	(1.19%)	
	3238	117	3355
Pearson chi2(1) = 22.8296 Pr = 0.000			

(2) PSM

	LENGTHEN_TC = 0	LENGTHEN_TC = 1	Total
REDUCE_PURCHASE= 0	55	50	105
	(37.67%)	(34.25%)	
REDUCE_PURCHASE= 1	13	28	41
	(8.90%)	(19.18%)	
	68	78	146
Pearson chi2(1) = 5.0647 Pr = 0.024			

Table 4 Fraction and cross-tabulation (COVID sample)

This table shows the average value of REDUCE_PURCHASE by LENGTHEN_TC and the cross-tabulations for LENGTHEN_TC and REDUCE_PURCHASE. *** denotes significance at the 1% level.

Panel A: Fraction

	LENGTHEN_TC = 0	LENGTHEN_TC = 1	Difference
(1) Whole sample	0.056	0.370	0.315 ***
(2) PSM	0.154	0.359	0.205 **

Panel B: Cross-tabulation

(1) Whole sample

	LENGTHEN_TC = 0	LENGTHEN_TC = 1	
REDUCE_PURCHASE= 0	3506	34	3540
	(93.07%)	(0.90%)	
REDUCE_PURCHASE= 1	207	20	227
	(5.50%)	(0.53%)	
	3713	54	3767
Pearson chi2(1) = 93.0376 Pr = 0.000			

(2) PSM

	LENGTHEN_TC = 0	LENGTHEN_TC = 1	
REDUCE_PURCHASE= 0	31	25	56
	(41.33%)	(33.33%)	
REDUCE_PURCHASE= 1	5	14	19
	(6.67%)	(18.67%)	
	36	39	75
Pearson chi2(1) = 4.7937 Pr = 0.029			

Table 5 Multinomial logit model: Parsimonious (GFC sample)

This table shows the estimation results for multinomial logit models for LENGTHEN_TC and REDUCE_PURCHASE. For more detailed definition of dependent and independent variables, see Table 1. ***, **, and * respectively indicate that the coefficient is statistically significant at the 1%, 5%, and 10% level. Robust standard errors are in parentheses.

Panel A: Estimation results for multinomial logit models

	[1] Parsimonious specification				[2] Full specification			
	(i)	(ii)	(iii)	(iv)	(i)	(ii)	(iii)	(iv)
REDUCE_PURCHASE =	0	0	1	1	0	0	1	1
LENGTHEN_TC =	0	1	0	1	0	1	0	1
LARGE	(benchmark case)				(benchmark case)	-0.5585	-0.1633	-0.1280
						(0.371)	(0.138)	(0.489)
S_PURCHASE						0.3247	-0.0118	-0.5803
						(0.645)	(0.259)	(0.903)
ln(S_RELATION)						0.3764	0.1080	0.2922
						(0.327)	(0.119)	(0.409)
M_BANK1		0.6701**	0.9011***	0.7522*		0.7655**	1.0099***	0.8492*
		(0.275)	(0.111)	(0.397)		(0.359)	(0.145)	(0.516)
M_BANK2		1.5692***	1.1783***	1.9845***		1.6833***	1.2126***	1.9411***
		(0.344)	(0.228)	(0.437)		(0.429)	(0.291)	(0.537)
ln(B_RELATION)						-0.2582	-0.0594	-0.0410
						(0.192)	(0.076)	(0.289)
SHK_CUS _REAL1		0.1496	0.2824***	0.3964		0.0672	0.2697**	-0.1486
		(0.263)	(0.105)	(0.356)		(0.332)	(0.132)	(0.445)
SHK_CUS _REAL2		0.3241	1.0595***	1.2832*		0.3957	0.9232***	1.7587*
		(0.347)	(0.161)	(0.746)		(0.475)	(0.204)	(1.057)
SHK_CUS _FIN		1.2955***	0.2694*	1.5757***		1.5463***	0.3174*	1.5882***
		(0.261)	(0.139)	(0.349)		(0.320)	(0.166)	(0.431)
SHK_SUP_REAL		0.3716	0.4541***	1.4906***		0.4021	0.5697***	1.4220***
		(0.362)	(0.144)	(0.370)		(0.447)	(0.176)	(0.470)
ln(EMP)		-0.0218	0.0751	0.1542		-0.0342	0.0211	0.3060
		(0.139)	(0.051)	(0.179)		(0.187)	(0.072)	(0.241)
ln(AGE)		-0.2260	-0.0009	-0.3386		-0.3700	-0.0617	-0.5532
		(0.233)	(0.105)	(0.315)		(0.370)	(0.154)	(0.513)
SCORE		-0.0938***	0.0019	-0.1151***		-0.1116***	0.0048	-0.1671***
		(0.022)	(0.009)	(0.032)		(0.030)	(0.012)	(0.041)
ln(BORROW)		0.0163	-0.0112	0.0143		0.0905	-0.0016	0.0204
		(0.078)	(0.027)	(0.106)		(0.116)	(0.045)	(0.156)
Industry Fixed Effects	Yes				Yes			
Observations	3,355				2,106			
Log Likelihood	-1855				-1136			

Panel B: Marginal effects of shock variables

	[1] Parsimonious specification				[2] Full specification			
	(i)	(ii)	(iii)	(iv)	(i)	(ii)	(iii)	(iv)
REDUCE_PURCHASE =	0	0	1	1	0	0	1	1
LENGTHEN_TC =	0	1	0	1	0	1	0	1
LARGE					0.0291	-0.0109	-0.0179	-0.0003
					(0.019)	(0.008)	(0.017)	(0.006)
S_PURCHASE					0.0008	0.0076	-0.0012	-0.0072
					(0.035)	(0.014)	(0.033)	(0.011)
ln(S_RELATION)					-0.0209	0.0071	0.0112	0.0026
					(0.016)	(0.007)	(0.015)	(0.005)
M_BANK1	-0.1235***	0.0096*	0.1091***	0.0049	-0.1391***	0.0106	0.1225***	0.0060
	(0.014)	(0.006)	(0.014)	(0.004)	(0.019)	(0.007)	(0.018)	(0.006)
M_BANK2	-0.1795***	0.0261***	0.1368***	0.0166***	-0.1856***	0.0277***	0.1409***	0.0170***
	(0.029)	(0.007)	(0.028)	(0.005)	(0.037)	(0.009)	(0.036)	(0.006)
ln(B_RELATION)					0.0114	-0.0051	-0.0063	0.0000
					(0.010)	(0.004)	(0.010)	(0.003)
SHK_CUS _REAL1	-0.0389***	0.0016	0.0340***	0.0033	-0.0322*	0.0004	0.0345**	-0.0027
	(0.014)	(0.005)	(0.013)	(0.004)	(0.018)	(0.007)	(0.017)	(0.005)
SHK_CUS _REAL2	-0.1407***	0.0012	0.1290***	0.0105	-0.1298***	0.0020	0.1104***	0.0174
	(0.021)	(0.007)	(0.020)	(0.008)	(0.027)	(0.010)	(0.026)	(0.013)
SHK_CUS _FIN	-0.0637***	0.0245***	0.0241	0.0151***	-0.0736***	0.0292***	0.0287	0.0158***
	(0.018)	(0.006)	(0.017)	(0.004)	(0.022)	(0.007)	(0.021)	(0.005)
SHK_SUP_REAL	-0.0705***	0.0045	0.0515***	0.0145***	-0.0850***	0.0042	0.0664***	0.0145**
	(0.019)	(0.007)	(0.018)	(0.004)	(0.024)	(0.009)	(0.022)	(0.006)

Table 6 Multinomial logit model: Parsimonious (COVID sample)

This table shows the estimation results for multinomial logit models for LENGTHEN_TC and REDUCE_PURCHASE. For more detailed definition of dependent and independent variables, see Table 1. ***, **, and * respectively indicate that the coefficient is statistically significant at the 1%, 5%, and 10% level. Robust standard errors are in parentheses.

Panel A: Estimation results for multinomial logit models

	[1] Parsimonious specification				[2] Full specification			
	(i)	(ii)	(iii)	(iv)	(i)	(ii)	(iii)	(iv)
REDUCE_PURCHASE =	0	0	1	1	0	0	1	1
LENGTHEN_TC =	0	1	0	1	0	1	0	1
LARGE	(benchmark case)				(benchmark case)	0.4366	0.2069	-0.7434
						(0.455)	(0.192)	(1.030)
S_PURCHASE						-1.3495	-0.7074**	0.4013
						(0.897)	(0.348)	(1.428)
ln(S_RELATION)						-0.1934	0.1114	0.0924
						(0.307)	(0.148)	(0.672)
M_BANK1		0.0698	0.4936***	0.4105		-0.3532	0.2055	0.2112
		(0.379)	(0.168)	(0.803)		(0.446)	(0.194)	(1.007)
M_BANK2		1.1705***	0.3826*	3.8630***		1.4134***	0.3734	4.2318***
		(0.424)	(0.204)	(0.866)		(0.491)	(0.248)	(1.082)
ln(B_RELATION)						0.3936	0.2089*	1.1110
						(0.364)	(0.118)	(0.753)
SHK_CUS _REAL1		0.5956	-0.0627	-1.1581		0.4555	-0.0372	-1.1542
		(0.439)	(0.219)	(0.792)		(0.517)	(0.248)	(0.968)
SHK_CUS _REAL2		1.4455***	1.8866***	13.8560		1.7116***	1.9165***	15.2675
		(0.512)	(0.259)	(533.069)		(0.650)	(0.295)	(1,277.417)
SHK_CUS _FIN		1.4239***	-0.2842	2.3465***		1.6152***	-0.2737	2.0054**
		(0.456)	(0.324)	(0.698)		(0.523)	(0.363)	(0.815)
SHK_SUP_REAL		-1.1364	1.6182***	4.1716***		-0.8011	1.4809***	4.4390***
		(1.065)	(0.231)	(0.789)		(1.081)	(0.270)	(1.022)
ln(EMP)		-0.2348	-0.0395	-0.0132		-0.3058	-0.0743	-0.1543
		(0.184)	(0.072)	(0.341)		(0.226)	(0.087)	(0.433)
ln(AGE)		0.5186	-0.0207	0.8024		0.1785	-0.2669	0.2673
		(0.375)	(0.119)	(0.553)		(0.514)	(0.168)	(0.762)
SCORE		0.0058	-0.0285*	0.0855		0.0017	-0.0281	0.0116
		(0.034)	(0.015)	(0.069)		(0.040)	(0.018)	(0.086)
ln(BORROW)		0.0586	-0.0510	-0.0890		0.0438	-0.0825*	0.3390
		(0.095)	(0.039)	(0.182)		(0.111)	(0.046)	(0.293)
Industry Fixed Effects	Yes				Yes			
Observations	3767				2,580			
Log Likelihood	-888.6				-645.1			

Panel B: Marginal effects of shock variables

	[1] Parsimonious specification				[2] Full specification			
	(i)	(ii)	(iii)	(iv)	(i)	(ii)	(iii)	(iv)
REDUCE_PURCHASE =	0	0	1	1	0	0	1	1
LENGTHEN_TC =	0	1	0	1	0	1	0	1
LARGE					-0.0120	0.0040	0.0110	-0.0030
					(0.011)	(0.004)	(0.010)	(0.004)
S_PURCHASE					0.0453**	-0.0119	-0.0357**	0.0023
					(0.020)	(0.009)	(0.018)	(0.005)
ln(S_RELATION)					-0.0042	-0.0019	0.0059	0.0003
					(0.008)	(0.003)	(0.008)	(0.002)
M_BANK1	-0.0241***	0.0002	0.0230***	0.0009	-0.0079	-0.0035	0.0108	0.0006
	(0.009)	(0.003)	(0.008)	(0.003)	(0.011)	(0.004)	(0.010)	(0.004)
M_BANK2	-0.0357***	0.0095**	0.0140	0.0123***	-0.0412***	0.0120**	0.0143	0.0148***
	(0.010)	(0.004)	(0.009)	(0.003)	(0.014)	(0.005)	(0.012)	(0.004)
ln(B_RELATION)					-0.0165**	0.0033	0.0095	0.0038
					(0.007)	(0.003)	(0.006)	(0.003)
SHK_CUS _REAL1	0.0008	0.0054	-0.0024	-0.0038	0.0011	0.0044	-0.0013	-0.0042
	(0.011)	(0.004)	(0.010)	(0.003)	(0.014)	(0.005)	(0.013)	(0.004)
SHK_CUS _REAL2	-0.1299	0.0097	0.0764	0.0438	-0.1494	0.0116	0.0842	0.0536
	(1.225)	(0.063)	(0.468)	(1.756)	(3.315)	(0.211)	(1.121)	(4.647)
SHK_CUS _FIN	-0.0036	0.0123***	-0.0165	0.0078***	-0.0047	0.0148***	-0.0174	0.0073**
	(0.016)	(0.004)	(0.015)	(0.002)	(0.019)	(0.005)	(0.019)	(0.003)
SHK_SUP_REAL	-0.0748***	-0.0115	0.0739***	0.0125***	-0.0790***	-0.0095	0.0734***	0.0150***
	(0.014)	(0.009)	(0.011)	(0.003)	(0.017)	(0.010)	(0.014)	(0.004)

Table A1: Estimated Results of the Probit Estimation and Balancing Test (Global financial crisis)

This table presents estimates from the maximum-likelihood probit regressions with LENGTHEN_TC as the dependent variable. Definitions of variables are shown in Table . ***, **, and * respectively indicate that the coefficient is statistically significant at the 1%, 5%, and 10% level. Standard errors are in parentheses.

Panel A: Estimated Results of the Probit Estimation

	(1)
	LENGTHEN_TC
LARGE	-0.1719
	(0.1397)
S_PURCHASE	0.0065
	(0.2499)
ln(S_RELATION)	0.1437
	(0.1214)
M_BANK1	0.3094**
	(0.1385)
M_BANK2	0.7522***
	(0.1847)
ln(B_RELATION)	-0.0882
	(0.0761)
SHK_CUS _REAL1	0.0230
	(0.1274)
SHK_CUS _REAL2	0.2717
	(0.1916)
SHK_CUS _FIN	0.7249***
	(0.1300)
ln(EMP)	0.0432
	(0.0708)
ln(AGE)	-0.1864
	(0.1438)
SCORE	-0.0609***
	(0.0120)
ln(BORROW)	0.0318
	(0.0458)
Industry Fixed Efects	Yes
Observations	2103

Panel B: Difference in Variables for Matching Before and After Matching

Variable		Mean LENGTHEN_TC = 1	LENGTHEN_TC = 0	t	p>t
LARGE	Unmatched	0.269	0.449	-3.140	0.002
	Matched	0.269	0.333	-0.870	0.386
S_PURCHASE	Unmatched	0.354	0.349	0.160	0.872
	Matched	0.354	0.331	0.550	0.584
ln(S_RELATION)	Unmatched	3.060	3.171	-1.460	0.145
	Matched	3.060	3.042	0.180	0.857
M_BANK1	Unmatched	0.744	0.523	3.830	0.000
	Matched	0.744	0.833	-1.370	0.172
M_BANK2	Unmatched	0.256	0.031	10.270	0.000
	Matched	0.256	0.269	-0.180	0.857
ln(B_RELATION)	Unmatched	2.778	2.847	-0.500	0.620
	Matched	2.778	2.807	-0.180	0.858
SHK_CUS _REAL1	Unmatched	0.410	0.343	1.220	0.222
	Matched	0.410	0.449	-0.480	0.630
SHK_CUS _REAL2	Unmatched	0.910	0.791	2.570	0.010
	Matched	0.910	0.872	0.770	0.444
SHK_CUS _FIN	Unmatched	0.462	0.135	8.090	0.000
	Matched	0.462	0.487	-0.320	0.750
ln(EMP)	Unmatched	2.908	3.439	-3.520	0.000
	Matched	2.908	3.057	-0.760	0.451
ln(AGE)	Unmatched	3.339	3.539	-3.250	0.001
	Matched	3.339	3.339	0.000	0.998
SCORE	Unmatched	48.564	54.565	-7.910	0.000
	Matched	48.564	49.859	-1.500	0.136
ln(BORROW)	Unmatched	4.829	4.836	-0.030	0.979
	Matched	4.829	4.907	-0.260	0.798
Manufacturing	Unmatched	0.192	0.257	-1.280	0.200
	Matched	0.192	0.179	0.200	0.838
Information and Communications	Unmatched	0.026	0.024	0.080	0.935
	Matched	0.026	0.051	-0.830	0.408
Transportations	Unmatched	0.026	0.026	0.000	0.998
	Matched	0.026	0.077	-1.450	0.148
Wholesales	Unmatched	0.167	0.253	-1.730	0.083
	Matched	0.167	0.141	0.440	0.660
Retail	Unmatched	0.103	0.107	-0.120	0.908
	Matched	0.103	0.026	1.970	0.050
Real Estate	Unmatched	0.013	0.017	-0.300	0.766
	Matched	0.013	0.000	1.000	0.319
Other services	Unmatched	0.038	0.085	-1.460	0.145
	Matched	0.038	0.013	1.010	0.314
Others	Unmatched	0.013	0.008	0.420	0.677
	Matched	0.013	0.000	1.000	0.319

Table A2: Estimated Results of the Probit Estimation and Balancing Test (COVID-19 shock)

This table presents estimates from the maximum-likelihood probit regressions with LENGTHEN_TC as the dependent variable. Definitions of variables are shown in Table . ***, **, and * respectively indicate that the coefficient is statistically significant at the 1%, 5%, and 10% level. Standard errors are in parentheses.

Panel A: Estimated Results of the Probit Estimation

	(1)
	LENGTHEN_TC
LARGE	0.0711
	(0.1714)
S_PURCHASE	-0.4342
	(0.3198)
ln(S_RELATION)	-0.0649
	(0.1225)
M_BANK1	-0.0452
	(0.1669)
M_BANK2	0.8949***
	(0.1760)
ln(B_RELATION)	0.1569
	(0.1297)
SHK_CUS _REAL1	0.2165
	(0.1862)
SHK_CUS _REAL2	0.7365***
	(0.2553)
SHK_CUS _FIN	0.9035***
	(0.1903)
ln(EMP)	-0.1249
	(0.0840)
ln(AGE)	0.1341
	(0.1811)
SCORE	0.0086
	(0.0148)
ln(BORROW)	0.0293
	(0.0438)
Industry Fixed Efects	Yes
Observations	2449

Panel B: Difference in Variables for Matching Before and After Matching

Variable		Mean LENGTHEN_TC = 1	LENGTHEN_TC = 0	t	p>t
LARGE	Unmatched	0.359	0.396	-0.470	0.637
	Matched	0.359	0.308	0.470	0.636
S_PURCHASE	Unmatched	0.334	0.367	-0.760	0.446
	Matched	0.334	0.312	0.380	0.705
ln(S_RELATION)	Unmatched	3.178	3.233	-0.490	0.625
	Matched	3.178	2.675	3.000	0.004
M_BANK1	Unmatched	0.641	0.432	2.610	0.009
	Matched	0.641	0.513	1.140	0.258
M_BANK2	Unmatched	0.513	0.088	9.160	0.000
	Matched	0.513	0.538	-0.220	0.823
ln(B_RELATION)	Unmatched	3.466	3.231	1.550	0.121
	Matched	3.466	3.368	0.630	0.534
SHK_CUS _REAL1	Unmatched	0.333	0.103	4.630	0.000
	Matched	0.333	0.333	0.000	1.000
SHK_CUS _REAL2	Unmatched	0.923	0.541	4.770	0.000
	Matched	0.923	0.974	-1.020	0.311
SHK_CUS _FIN	Unmatched	0.359	0.048	8.760	0.000
	Matched	0.359	0.256	0.970	0.333
ln(EMP)	Unmatched	2.963	3.164	-0.950	0.345
	Matched	2.963	3.052	-0.280	0.780
ln(AGE)	Unmatched	3.702	3.668	0.380	0.702
	Matched	3.702	3.571	1.070	0.289
SCORE	Unmatched	49.538	51.547	-1.860	0.063
	Matched	49.538	49.410	0.080	0.940
ln(BORROW)	Unmatched	4.857	4.168	1.760	0.079
	Matched	4.857	5.273	-0.930	0.356
Manufacturing	Unmatched	0.205	0.268	-0.880	0.381
	Matched	0.205	0.205	0.000	1.000
Transportations	Unmatched	0.026	0.023	0.120	0.907
	Matched	0.026	0.051	-0.580	0.562
Wholesales	Unmatched	0.103	0.085	0.400	0.691
	Matched	0.103	0.026	1.390	0.170
Retail	Unmatched	0.128	0.064	1.620	0.106
	Matched	0.128	0.154	-0.320	0.749
Other services	Unmatched	0.077	0.066	0.280	0.776
	Matched	0.077	0.128	-0.740	0.462
Others	Unmatched	0.103	0.129	-0.490	0.624
	Matched	0.103	0.103	0.000	1.000
(Unknown)	Unmatched	0.231	0.125	1.970	0.049
	Matched	0.231	0.282	-0.510	0.610