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FINANCIAL DISTRESS AND INDUSTRY STRUCTURE: AN INTER-INDUSTRY APPROACH TO THE LOST DECADE IN JAPAN

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This paper proposes a novel approach to investigating the propagation mechanism of balance sheet deterioration in financial institutions and firms, by extending the input–output analysis. First, we use a unique input–output table augmented by firm size dimension. Second, we link the input–output table with the balance sheet conditions of financial institutions and firms. Based on Japanese input–output tables, we find that the lending attitude of financial institutions affected firms' input decision in the late 1990s and the early 2000s. Simulation exercises are conducted to evaluate the effects of changes in the lending attitude toward small firms as favorable as that toward large firms on sectoral allocations. We find that output was increased for small firms and reduced for large firms. The change in output was non-negligible, about 5.5% of the initial output of each sector. In particular, it exceeded 20% in textile, iron and steel and fabricated metal products.

Keywords: Input–output analysis; Trade credit; Balance sheet; Multiplier

1. INTRODUCTION

In Japan, the period of the 1990s and the early 2000s is called the lost decade, and during this period, the balance sheets of financial institutions and firms deteriorated greatly. Many studies report that this had perverse effects on firms' activities.[1] This paper investigates the effects of the balance sheet deterioration of financial institutions and firms on the inter-industry structure. Input–output analysis is a powerful tool for examining the inter-industry relationship from the general equilibrium viewpoint. Employing this input–output technique, this paper investigates how the balance sheet deterioration of financial institutions

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[1] For example, see Nishimura et al. (2005), Caballero et al. (2008) and Ogawa (2003a, 2003b) for the effects of balance sheet deterioration on firms' entry and exit, and investment and employment decisions.

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and firms is propagated across sectors and then quantitatively evaluates the extent to which the sectoral distribution is affected by balance sheet deterioration.[2]

Our study is related to two strands of literature. First, there is a growing literature of multisectoral general equilibrium models that are intended to explain the transmission of sectoral shocks through input–output linkages. This literature includes Long and Plosser (1983), Basu (1995), Hornstein and Praschnik (1997), Horvath (1998, 2000), Dupor (1999), Bergin and Feenstra (2000), Huang and Liu (2001) and Shea (2002).

Second, there are studies shedding light on the transmission mechanism of sectoral shocks through credit chains. To illustrate in this framework how a deterioration in the balance sheet of one firm is transmitted to other firms through inter-industry credit chains, suppose that customer A is hit by liquidity shock. Supplier B will withhold completion of goods ordered from customer A. Thus, supplier B will also run into liquidity problems, which in turn will affect the suppliers that provide supplier B with intermediate goods. In this manner, an output reduction in one industry resulting from balance sheet deterioration may be propagated into other industries and thus eventually affect aggregate production. The studies of Kiyotaki and Moore (1997, 2002) are pioneering studies, which show that a small, temporary shock to the liquidity of some firms generates a large, persistent fall in aggregate activity. The studies of Boissay (2006), Raddatz (2010) and Tsujimura and Tsujimura (2011) are studies along this line.

The above discussions illustrate the importance of taking the inter-industry linkages into consideration when investigating the propagation of financial distress in one sector across sectors.[3] Our study is on the same track with the two strands of the literature in the sense that we investigate the propagation mechanism of balance sheet shocks in one sector into the other sectors based on the input–output tables.

We extend the conventional input–output analysis in two directions. First, we use input–output tables classified by firm size for the manufacturing sector. Specifically, the input structure of the jth industry from the ith industry is described by four input–output coefficients, rather than by one, as in the conventional input–output table, because the input and output sectors are each divided into large and small firms. Thus, we obtain much richer information on the inter-industry relationship than what a conventional input–output table provides. The information in input–output tables classified by firm size is very useful in analyzing the inter-industry structure of the lost decade in Japan, because it is often argued that the balance sheet deterioration of financial institutions forced small firms to rely more on trade credit from large firms in order to meet their financial needs.

It is a tacit assumption underlying the credit chain argument that the firms hit by liquidity shocks are credit constrained. It is true that small-sized firms are liquidity constrained, but large firms have ample liquid assets to absorb the liquidity shocks coming from default of their customers. The upshot is that credit contagion might be cushioned to some extent by

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[2] Kobayashi and Inaba (2002) analyzed the propagation mechanism of coordination failure in one sector triggered by non-performing loans in the banking sector, but this approach does not take full advantage of input–output tables, whereas ours does. Tsuruta (2007) investigated whether credit contagion leads to a decrease in trade credit supply for small businesses, using the micro-data of the Credit Risk Database. Tsuruta's study does not take full interplays among sectors into consideration.

[3] In a slightly different context, Lang and Stulz (1992) and Hertzel et al. (2008), using bankruptcy filing data, examined the extent to which distress and bankruptcy filing have valuation consequences for suppliers and customers of filing firms. However, they are silent on the macroeconomic consequence of financial distress.

the existence of large suppliers in a network of firms. We can examine this possibility, using the input–output tables classified by firm size.

Second, we specify the coefficients of the input–output table as a function of the balance sheet conditions of suppliers, buyers and financial institutions.[4] When a firm inputs certain goods into the production process, it makes a decision about how much to purchase from large suppliers and small suppliers. It is quite legitimate that the customer will place an order with small and large suppliers to diversify the delivery risks. However, the delivery risk of one supplier will depend on that supplier's balance sheet conditions since it is likely that when the supplier is burdened with excessive debt, it might have difficulty raising working capital to maintain production activities. Then, the customer will switch to another supplier with a healthier balance sheet. Thus, the balance sheet conditions of suppliers will matter for the customer's input decision.

Furthermore, it is often argued that large firms with easy access to bank credit and other external financing can distribute their credit to their small customers by way of trade credit. This is the so-called redistributional view of trade credit.[5] It should be noted that bank credit availability to large firms depends on the balance sheet conditions of financial institutions. When the health of financial institutions deteriorates, credit available to large firms decreases, which in turn forces them to reduce the supply of trade credit to small firms. This suggests that the buyer may prefer a large supplier that has a relationship with healthy financial institutions. In this way, the input decision also depends on the balance sheet conditions of financial institutions.

Deterioration of the balance sheet of one sector and/or financial institutions affects the input decisions among small and large suppliers, which in turn will be propagated across sectors and eventually affect the aggregate output. We can quantitatively examine how a change in the balance sheet conditions of firms and financial institutions affects the substitution of intermediate inputs between large and small firms.

To preview our findings, we find that the lending attitude of financial institutions toward suppliers, a proxy for the balance sheet conditions of the financial sector, affected buyers' input decisions in the late 1990s and the early 2000s, when Japanese financial institutions suffered from excessive non-performing loans. Specifically, in the lost decade, customers, irrespective of their size, preferred to purchase intermediate inputs from those suppliers that faced an easier lending attitude, rather than from those facing a more severe lending attitude. We also find that customers, irrespective of their size, increased purchase of intermediate inputs from large suppliers when the liquidity of small suppliers was reduced, small suppliers became increasingly dependent on debt and/or sales growth of large suppliers increased in the lost decade. To gauge the quantitative importance of our findings, we conduct simulation exercises to establish the extent to which a change in the lending attitude affects the output of each industry, via change in inter-industry transactions. We find that an easier lending

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[4] We just focus on the balance sheet conditions that affect the input–output coefficients in this study. There are other factors, such as production capacity of the supplier, that affect the choice between large and small firms as intermediate goods suppliers. These factors are subsumed into the fixed-effects and/or time dummies in our specification.

[5] See Meltzer (1960), Jaffee (1971), Ramey (1992), Petersen and Rajan (1997), McMillan andWoodruff (1999), Nilsen (2002), De Haan and Sterken (2006) and Love et al. (2007) for evidence on the validity of the redistributional view of trade credit in the USA and other countries. For the Japanese evidence, see Takehiro and Ohkusa (1995), Ono (2001), Ogawa (2003c), Uesugi and Yamashiro (2004), Uesugi (2005), Fukuda et al. (2006), Taketa and Udell (2007), Uchida et al. (2006), Tsuruta (2008) and Ogawa et al. (2011).

attitude toward small suppliers increased the output in the small firm sector and reduced the output in the large firm sector. This suggests that differential changes in the lending attitude toward the large firm sector and the small firm sector bring about distributional changes in intermediate inputs across sectors with different firm sizes, which in turn leads to non-negligible changes in the sectoral outputs.

The paper is organized as follows. Section 2 discusses the determinants of the input–output structure theoretically. Section 3 derives the basic equation to be estimated and describes the data set that we use. Section 4 interprets the estimation results that we obtained, and Section 5 presents the results of the simulation exercises. Section 6 concludes this study.

2. DETERMINANTS OF THE INPUT–OUTPUT STRUCTURE: THEORETICAL DISCUSSIONS

In traditional input–output analysis, the input–output coefficient is technically determined. Suppose that a firm has the following constant-returns-to-scale Cobb–Douglas production technology:[6]

$$Y = AL^{\alpha_{\mathrm{L}}}K^{\alpha_K}M_1^{\alpha_{M_1}} \cdots M_N^{\alpha_{M_N}}, \tag{1}$$

where Y is the gross output, L the labor, K the capital, M_i the intermediary input from the ith industry $(i = 1, \ldots, N)$ and $\alpha_{\mathrm{L}}, \alpha_K, \alpha_{M_1}, \ldots, \alpha_{M_N}$ the technology parameters with $\alpha_{\mathrm{L}} + \alpha_K + \sum_{i=1}^{N} \alpha_{M_i} = 1$.

The firm determines the optimal ratio of intermediary inputs to gross output that maximizes its profit(π), defined as follows:

$$\pi = pY - wL - rK - \sum_{i=1}^{N} p_{M_i}M_i, \tag{2}$$

where p is the output price, w the wage rate, r the rental price of capital and P_{M_i} the price of the ith intermediary input.

The first-order conditions yield the following input demand function for intermediary goods:

$$\frac{p_{M_i}M_i}{pY} = \alpha_{M_i} \quad (i = 1, 2, \ldots, N). \tag{3}$$

This equation shows that the input–output coefficients on value terms are simply the technology parameters of the production function.

When a firm has the option to purchase the ith intermediary input from two suppliers, a large firm and a small firm, we have to specify how the customer determines the proportion of intermediary goods purchased from each supplier. Three determinants affect the customer's decision to purchase from large or small suppliers. First, the firm can reduce the risk that the order placed for the intermediary inputs is not delivered as scheduled, by diversifying

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[6] In this paper, we use lowercase italic letters such as w, r, p or m for prices or ratios and uppercase italic letters such as Y, K, L and M for quantity variables. For example, w and L stand for wage rate and number of employees, respectively, and accordingly the product wL presents the compensation of employees. As for the matrices and vectors, we follow the standard mathematical notations.

the orders from large and small suppliers. The total amount of the ith intermediary input necessary to attain optimal production is rewritten from Equation 3 as

$$M_i^* = \frac{\alpha_{M_i} pY}{p_{M_i}}. \tag{4}$$

Given the optimal amount of the ith intermediary input given by Equation 4, the firm determines the proportion of intermediary goods that it orders from large and small suppliers in a way that minimizes the expected loss from failing to attain the profit-maximizing level of intermediary input. Formally, the objective function of the customer is written as

$$\mathrm{E}[M_i^* - \tilde{a}_{iL} M_{iL} - \tilde{a}_{iS} M_{iS}]^2, \tag{5}$$

where M_{iL} is the amount ordered from large suppliers, M_{iS} the amount ordered from small suppliers, $\tilde{a}_{iL}$ the stochastic factor that affects the realization of the order from large firms and $\tilde{a}_{iS}$ the stochastic factor that affects the realization of the order from small firms.

The idea underlying our formulation is as follows. The firm knows the optimal total amount of intermediary goods and places orders with large and small suppliers. However, it takes some time for the ordered goods to be delivered to the customer, and there is always some possibility that the goods delivered will fall short of those ordered, due to stochastic shocks. Therefore, the customer has an incentive to lessen the risk by diversifying the orders between large and small suppliers. Formally, the firm minimizes Equation 5 subject to the following constraint:

$$M_{iL} + M_{iS} = M_i^*. \tag{6}$$

The first condition yields the following demand function for the ith intermediary input of large suppliers:

$$\frac{M_{iL}}{M_i^*} = \frac{\mathrm{E}[\tilde{a}_{iL}] - \mathrm{E}[\tilde{a}_{iS}] + \mathrm{E}[\tilde{a}_{iS}^2] - \mathrm{E}[\tilde{a}_{iL}\tilde{a}_{iS}]}{\mathrm{E}[(\tilde{a}_{iL} - \tilde{a}_{iS})^2]}. \tag{7}$$

The term $\mathrm{E}[\tilde{a}_{iL}] - \mathrm{E}[\tilde{a}_{iS}]$ measures the difference in the mean of the stochastic factors. Here, we assume that $\mathrm{E}[\tilde{\alpha}_{iL}] = \mathrm{E}[\tilde{\alpha}_{iS}]$. Then, Equation 7 is written simply as

$$m_{iL} = \frac{M_{iL}}{M_i^*} = \frac{\sigma_{iS}^2 - \sigma_{iSL}}{\sigma_{iS}^2 + \sigma_{iL}^2 - 2\sigma_{iSL}}, \tag{8}$$

where σ_{iS}^2 is the variance of $\tilde{a}_{iS}$, σ_{iL}^2 the variance of $\tilde{a}_{iL}$ and σ_{iSL} the covariance between $\tilde{a}_{iS}$ and $\tilde{a}_{iL}$.

Similarly, the demand function for the ith intermediary input of small suppliers is given by[7]

$$m_{iS} = \frac{M_{iS}}{M_i^*} = \frac{\sigma_{iL}^2 - \sigma_{iSL}}{\sigma_{iS}^2 + \sigma_{iL}^2 - 2\sigma_{iSL}}. \tag{9}$$

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[7] It can be shown that if the correlation coefficient between $\tilde{a}_{iS}$ and $\tilde{a}_{iL}$ (ρ_i) satisfies the condition $\rho_i < \min(\sigma_{iS}/\sigma_{iL}, \sigma_{iL}/\sigma_{iS})$, then $0 < m_{iL}, m_{iS} < 1$. In the subsequent analysis, we assume that this condition is satisfied. Then, Equations 8 and 9 imply that $\sigma_{iS}^2 - \sigma_{iSL} > 0, \sigma_{iL}^2 - \sigma_{iSL} > 0$.

We can show that when $\sigma_{iS}^2 > \sigma_{iL}^2$, $m_{iL} > m_{iS}$. In other words, if the delivery uncertainty of a small supplier is larger than that of a large supplier, the proportion purchased from the large supplier is larger than that purchased from the small supplier.[8]

Comparative statics also enable us to obtain the following results:

$$\frac{\partial m_{iL}}{\partial \sigma_{iL}^2} < 0, \quad \frac{\partial m_{iL}}{\partial \sigma_{iS}^2} > 0, \quad \frac{\partial m_{iS}}{\partial \sigma_{iS}^2} < 0, \quad \frac{\partial m_{iS}}{\partial \sigma_{iL}^2} > 0. \tag{10}$$

A rise in the delivery uncertainty of one supplier, measured by the variance of $\tilde{a}_{iS}$ or $\tilde{a}_{iL}$, will reduce the proportion of purchase from that supplier and will instead increase the proportion purchased from the other supplier. These results suggest that the degree of uncertainty about delivery is very important in determining the degree of diversification of intermediate inputs between large and small suppliers. Note that the degree of uncertainty about delivery depends crucially on the balance sheet conditions of the suppliers. When one supplier's balance sheet deteriorates, it is quite likely that the supplier will be forced to reduce production unless the supplier has abundant liquidity or external funding measures such as bank credit, bond, or new equity to maintain real activities and thus cannot deliver the contracted amount to its customers. Therefore, the customer has an incentive to increase its purchases from the supplier with a healthier balance sheet.

Second, the customer may prefer to purchase from large firms, since large suppliers have better access to credit and hence can redistribute the credit that they receive to their customers by way of trade credit. This is the redistributional aspect of trade credit. Note that credit availability to large firms depends on the balance sheet conditions of financial institutions. When the health of financial institutions deteriorates, bank credit available to large firms decreases, which forces them to reduce the supply of trade credit to small firms.[9] Therefore, the redistributional role of trade credit depends on the balance sheet conditions of financial institutions.

Finally, the market structure of intermediate goods is an important factor in determining the purchase pattern of intermediate inputs from large and small suppliers. When a market for intermediate goods is oligopolistic, purchase will be heavily dependent on large suppliers. On the other hand, dependence on large suppliers will be lower in a competitive intermediate goods market. It should be noted that the input–output coefficient in our context is no longer the parameter determined purely by production technologies. The input–output coefficient, say from a large supplier in the ith industry, is defined as

$$\frac{p_{M_i} M_{iL}}{pY} = \frac{p_{M_i} M_i}{pY} \cdot \frac{M_{iL}}{M_i} = \alpha_{M_i} \cdot \frac{M_{iL}}{M_i}. \tag{11}$$

The first term of the right-hand side of Equation 11 is the conventional input–output coefficient, which is technologically given, but the second term of the right-hand side of Equation 11 depends upon economic factors, such as the balance sheet conditions of suppliers and financial institutions and the market structure of intermediate goods.

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[8] This proposition and the subsequent comparative statics results remain essentially valid without constraint 6.

[9] Even if the health of the financial institutions deteriorates, large firms might cushion the impact of reduction of bank credit by financing directly in capital markets. In this case, reduction of trade credit to small firms might be alleviated to a certain extent.

3. MODEL SPECIFICATION AND THE DATA SET DESCRIPTION

3.1. Model Specification

In our model, the input–output coefficient has four dimensions: buyer, supplier, firm size of the buyer and firm size of the supplier. We assume that the economy consists of N industries. Consider the production structure of the small firm in the jth industry ($j = 1, 2, \ldots, N$). Suppose that the small firm in the jth industry buys $M_{iL,jS}$ units of input from the large firm in the ith industry when it produces Y_{jS} units of output. Then, the input–output coefficient ($a_{iL,jS}$) in value terms is defined as

$$a_{iL,jS} \equiv \frac{p_{M_i} M_{iL,jS}}{p_j Y_{jS}}. \tag{12}$$

The coefficient $a_{iL,jS}$ is a product of the input–output coefficient $p_{Mi}M_{i,jS}/p_j Y_{jS}$, where $M_{i,jS}$ is the total input from the ith industry to the small firm of the jth industry, and the proportion of inputs purchased from the large supplier of the ith industry $m_{iL,jS} \equiv p_{M_i} M_{iL,jS}/p_{M_i} M_{i,j\mathrm{S}}$. The former is an exogenous parameter of the Cobb–Douglas production technology, while the latter depends on economic factors, as described in the previous section.

Now, we make an econometric specification of the determinants of $m_{iL,jS}$. First, it will be affected by the balance sheet conditions of the suppliers. Deterioration in the balance sheet of the supplier may prevent the order placed from being delivered as scheduled. This effect can be captured by the debt outstanding relative to real activities of the large supplier and the small supplier of the ith industry, which we denote by DEBT_{iL} and DEBT_{iS}, respectively. A fall (rise) in DEBT_{iL} (DEBT_{iS}) will increase $m_{iL,jS}$.

Liquidity is another balance sheet variable of the supplier that we consider. When the supplier has abundant liquidity, production activities will be executed smoothly and thus the order placed will be delivered without delay. We denote the liquidity of the large supplier and the small supplier of the ith industry by LIQ_{iL} and LIQ_{iS}, respectively. An increase (decrease) in LIQ_{iL} (LIQ_{iS}) will increase $m_{iL,jS}$.

The redistributional view of trade credit implies that the bank credit that suppliers receive may be redistributed to their customers via trade credit. Therefore, the necessary condition for the redistributional view to hold is that the supplier receives sufficient credit from financial institutions. We use the lending attitude of financial institutions toward the supplier as a proxy for the availability of bank credit. The lending attitude of financial institutions to large suppliers and small suppliers of the ith industry is denoted by LEND_{iL} and LEND_{iS}, respectively. An increase (decrease) in LEND_{iL} (LEND_{iS}) will increase $m_{iL,jS}$.

Sales growth might also affect the purchase pattern of intermediate inputs between large and small suppliers. Higher sales growth will warrant stable supply of intermediate goods to customers. We denote the growth rate of sales of the large suppliers and the small suppliers of the ith industry by $\mathrm{SGROWTH}_{iL}$ and $\mathrm{SGROWTH}_{iS}$, respectively. A rise (fall) in $\mathrm{SGROWTH}_{iL}$ ($\mathrm{SGROWTH}_{iS}$) will increase $m_{iL,jS}$.

The market structure of the supplier is an important factor in determining the pattern of purchases from large and small suppliers. Market structure is captured in this study by the dummy variables, as follows.[10] In specifying the $m_{iL,jS}$ equation, we add the dummy

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[10] Note that the dummy variables also capture the determinants of input–output coefficients such as production capacity and stochastic factors in Equations 8 and 9.

variable $\mathrm{DUM}_{iL,jS}$ to represent individual effects $(i, j = 1, 2, \ldots, N)$. The variable $\mathrm{DUM}_{iL,jS}$ takes unity for the pair of large supplier in the ith industry and small customer in the jth industry, and zero elsewhere. Then, the average industry effect of the supplier is simply calculated as $(1/N) \sum_{j=1}^{N} \gamma_{iL,jS}$, where $\gamma_{iL,jS}$ is the coefficient estimate of $\mathrm{DUM}_{iL,jS}$.

Lastly, we take the balance sheet conditions of the buyer into consideration. The balance sheet variables are debt outstanding relative to real activities (DEBT_{jS}), liquidity (LIQ_{jS}) and sales growth rate ($\mathrm{SGROWTH}_{jS}$). We also add the lending attitude of financial institutions toward the small customer of the jth industry (LEND_{jS}) to the list of explanatory variables.

To sum up, the equation to be estimated is written as[11]

$$\begin{aligned} m_{iL,jS} = {} & \gamma_0 + \gamma_1 \mathrm{LIQ}_{iL} + \gamma_2 \mathrm{LIQ}_{iS} + \gamma_3 \mathrm{DEBT}_{iL} + \gamma_4 \mathrm{DEBT}_{iS} \\ & + \gamma_5 \mathrm{LEND}_{iL} + \gamma_6 \mathrm{LEND}_{iS} + \gamma_7 \mathrm{SGROWTH}_{iL} + \gamma_8 \mathrm{SGROWTH}_{iS} \\ & + \gamma_9 \mathrm{LIQ}_{jS} + \gamma_{10} \mathrm{DEBT}_{jS} + \gamma_{11} \mathrm{LEND}_{jS} + \gamma_{12} \mathrm{SGROWTH}_{jS} \\ & + \sum_{i=1}^{N} \sum_{j=1}^{N} \gamma_{iL,jS} \mathrm{DUM}_{iL,jS} + \sum_{t=1}^{T} \lambda_t D_t + \epsilon_{iL,jS} \quad (i, j = 1, 2, \ldots, N), \end{aligned} \tag{13}$$

where D_t is the time dummy and $\epsilon_{iL,jS}$ the disturbance term.

The proportion of inputs purchased from the small supplier of the ith industry ($m_{iS,jS}$) does not give any additional information, since $m_{iS,jS}$ is linearly related to $m_{iL,jS}$ as $1 - m_{iL,jS}$. Therefore, we use only the input information from large suppliers. As for the input customer, small customers and large customers may respond differently to changes in the balance sheet conditions and to those in the lending attitude of financial institutions. Therefore, Equation 13 is estimated separately for large customers. The equation to be estimated for large customers is written as

$$\begin{aligned} m_{iL,jL} = {} & \eta_0 + \eta_1 \mathrm{LIQ}_{iL} + \eta_2 \mathrm{LIQ}_{iS} + \eta_3 \mathrm{DEBT}_{iL} + \eta_4 \mathrm{DEBT}_{iS} \\ & + \eta_5 \mathrm{LEND}_{iL} + \eta_6 \mathrm{LEND}_{iS} + \eta_7 \mathrm{SGROWTH}_{iL} + \eta_8 \mathrm{SGROWTH}_{iS} \\ & + \eta_9 \mathrm{LIQ}_{jL} + \eta_{10} \mathrm{DEBT}_{jL} + \eta_{11} \mathrm{LEND}_{jL} + \eta_{12} \mathrm{SGROWTH}_{jL} \\ & + \sum_{i=1}^{N} \sum_{j=1}^{N} \eta_{iL,jL} \mathrm{DUM}_{iL,jL} + \sum_{t=1}^{T} \mu_t D_t + \epsilon_{iL,jL} \quad (i, j = 1, 2, \ldots, N). \end{aligned} \tag{14}$$

3.2. Data Set Description

The proportion of inputs purchased from either large suppliers or small suppliers ($m_{ik,jl}; k, l = S, L$) is directly estimated by the scale-wise input–output tables compiled by the *Applied Research Institute Japan*. We use the input–output tables of 1980, 1985, 1990, 1995 and 2000. In these tables, the sectors in the manufacturing industry are further divided into two sectors by firm size.[12] Since we restrict the analysis to the manufacturing industry, the total number of input coefficients used in our analysis is 1,960

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[11] Time dummies are also added to the equation to account for the effects of the macro-shocks common to each industry, since we pool different panels of input–output tables.

[12] The sector concordance between the input–output tables and the Financial Statement Statistics of Corporations is presented in Table A1 of the online appendix.

TABLE 1. Distribution of normalized input coefficients by year.

	(1) 1980	(2) 1985	(3) 1990	(4) 1995	(5) 2000	(6) Total
			Small firms			
$m_{iL,jS} = 0.0$	5	5	2	2	2	16
$0.0 < m_{iL,jS} \leq 0.1$	12	15	20	16	27	90
$0.1 < m_{iL,jS} \leq 0.2$	26	31	34	35	30	156
$0.2 < m_{iL,jS} \leq 0.3$	16	22	16	20	19	93
$0.3 < m_{iL,jS} \leq 0.4$	25	17	18	18	14	92
$0.4 < m_{iL,jS} \leq 0.5$	16	14	16	18	21	85
$0.5 < m_{iL,jS} \leq 0.6$	12	18	21	27	17	95
$0.6 < m_{iL,jS} \leq 0.7$	7	14	11	17	15	64
$0.7 < m_{iL,jS} \leq 0.8$	17	7	10	8	10	52
$0.8 < m_{iL,jS} \leq 0.9$	3	2	4	1	6	16
$0.9 < m_{iL,jS} < 1.0$	8	1	13	15	15	52
$m_{iL,jS} = 1.0$	18	16	1	2	4	41
Total	165	162	166	179	180	852
Fraction of 0 or 1 coefficients	0.139	0.130	0.018	0.022	0.033	0.067
Mean	0.463	0.406	0.401	0.416	0.414	0.420
Standard deviation	0.315	0.294	0.284	0.278	0.302	0.295
			Large firms			
$m_{iL,jL} = 0.0$	5	5	4	4	4	22
$0.0 < m_{iL,jL} \leq 0.1$	12	14	18	17	26	87
$0.1 < m_{iL,jL} \leq 0.2$	25	27	29	29	24	134
$0.2 < m_{iL,jL} \leq 0.3$	15	23	17	19	13	87
$0.3 < m_{iL,jL} \leq 0.4$	14	14	18	18	20	84
$0.4 < m_{iL,jL} \leq 0.5$	19	17	18	20	22	96
$0.5 < m_{iL,jL} \leq 0.6$	16	14	21	24	20	95
$0.6 < m_{iL,jL} \leq 0.7$	8	22	15	18	14	77
$0.7 < m_{iL,jL} \leq 0.8$	23	11	10	13	12	69
$0.8 < m_{iL,jL} \leq 0.9$	3	3	4	3	7	20
$0.9 < m_{iL,jL} < 1.0$	6	1	13	13	15	48
$m_{iL,jL} = 1.0$	20	17	2	4	4	47
Total	166	168	169	182	181	866
Fraction of 0 or 1 coefficients	0.151	0.131	0.036	0.044	0.044	0.080
Mean	0.488	0.435	0.416	0.436	0.428	0.440
Standard deviation	0.317	0.299	0.283	0.283	0.303	0.297

(= (14 suppliers) × (14 customers)×(5 years)×(2 firm sizes)).[13] In the estimation, we discard observations that report no input from a certain industry or negative values in the input–output tables. Also, some sectors have negative input coefficients mainly due to the treatment of waste or by-products. We also eliminate these observations from the sample.

[13] The total number of input coefficients is 3,920 (=1,960×2), but, as discussed above, the proportion of input purchased from small suppliers is linearly related to that purchased from large suppliers. Therefore, the number of input coefficients used in our analysis is 1960.

The distribution of the input coefficients ($m_{iL,jl}$; $l = S, L$) and the related descriptive statistics are presented in Table 1.[14] The mean of $m_{iL,jl}$ has remained relatively stable since 1985, irrespective of firm size. It ranges from 0.401 to 0.436. The mode of distribution also remains unaltered over time and is in the interval of 0.1 to 0.2, irrespective of firm size. The shape of the distribution is bimodal.

All the balance sheet variables are taken from *Financial Statistics of Corporations*, compiled by the Ministry of Finance. The debt outstanding relative to real activities (DEBT) is the debt–sales ratio (DEBTSR). The liquidity variable (LIQ) is defined as the ratio of cash, deposits and securities in current assets to sales. The lending attitude of financial institutions comes from *The Short-term Economic Survey of Enterprises or Tankan Survey*, released by the Bank of Japan.[15] The original series is available quarterly, so we use annual averages. The detailed description of sources and the procedure to construct the data is also presented in the online appendix to this paper.

4. ESTIMATION RESULTS AND THEIR IMPLICATIONS

Table 2 reports the estimation results.[16] The estimation is conducted for the whole period, the period from 1980 to 1990 and the period of the lost decade (1995 and 2000). First, we examine the estimation results for small customers. When the estimation is conducted for the whole period, the debt–sales ratio of large suppliers has a significantly negative effect on the proportion of purchases from large suppliers. An increase in the debt burden on large suppliers prompts small customers to rely more on small suppliers due to increasing uncertainty about the delivery of intermediate inputs from large suppliers with a shaky balance sheet. In the lost decade period, the debt–sales ratio of small suppliers exerts a significantly positive effect on the proportion of purchase from large suppliers. In other words, a rise in the debt–sales ratio of small suppliers induces small customers to depend more on large suppliers. We also find that the liquidity of small suppliers has negative effects on the proportion of purchase from large suppliers, implying that fall of liquidity of small suppliers prompts small customers to rely more on large suppliers more abundant in liquidity. Furthermore, in the lost decade period, the lending attitude of financial institutions toward large (small) suppliers has a significantly positive (negative) effect on the proportion of purchases from large suppliers. This result indicates that easing the lending attitude toward large suppliers and/or tightening the lending attitude toward small suppliers raise the proportion of purchases from large suppliers by small customers. This result is consistent with the redistributional view of trade credit. Lastly, we find that higher sales growth of

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[14] The original distribution of the input coefficients is given in Table A2 in the online appendix to this paper.

[15] The lending attitude of financial institutions is a subjective survey from the borrowers' viewpoint. We also have objective data such as amounts outstanding of loans and bills discounted by industry and firm size. However, the size of loan outstanding per se does not tell about the health of financial institutions because the size of loan outstanding is determined as an intersection of loan supply of financial institutions and loan demand by *borrowers* and thus reflects the factors underlying loan demand and supply. We prefer the lending attitude of financial institutions that is a subjective judgment by borrowers about the health of the financial institutions that affects the intermediate input decision.

[16] The estimation results remain essentially unaltered when the ratio of total borrowing to sales (BORRSR) is used as alternative measure of DEBT variable.

TABLE 2. Estimated results.

	(1) 1980–2000	(2) 1980–1990	(3) 1995–2000
Small customers			
LIQ_{iL}	0.2534 (1.34)	0.6207 (1.81)*	−0.6270 (1.21)
LIQ_{iS}	−0.0832 (0.77)	−0.1496 (0.42)	−0.3456 (3.36)***
DEBTSR_{iL}	−0.1476 (2.63)***	0.0184 (0.19)	−0.0203 (0.11)
DEBTSR_{iS}	0.0224 (0.36)	−0.4412 (2.88)***	0.3112 (3.41)***
LEND_{iL}	0.0004 (0.50)	0.0002 (0.14)	0.0047 (4.00)***
LEND_{iS}	−0.0008 (1.07)	0.0006 (0.44)	−0.0084 (4.95)***
$\mathrm{SGROWTH}_{iL}$	0.1482 (2.41)**	0.0283 (0.38)	0.3626 (2.52)**
$\mathrm{SGROWTH}_{iS}$	0.0266 (1.37)*	0.0401 (1.11)	0.1349 (5.20)***
LIQ_{jS}	0.0393 (0.38)	−0.0683 (0.22)	−0.0259 (0.33)
DEBTSR_{jS}	−0.0612 (0.96)	0.0563 (0.39)	0.0353 (0.65)
LEND_{jS}	−0.0007 (1.48)	−0.0009 (0.98)	0.0002 (0.15)
$\mathrm{SGROWTH}_{jS}$	0.0012 (0.06)	−0.0352 (0.99)	0.0007 (0.03)
$D1985$	−0.0175 (0.51)		
$D1990$	−0.0311 (1.33)		
$D1995$	−0.0232 (0.64)	−0.0200 (0.36)	
$D2000$	−0.0402 (1.48)	−0.0202 (0.49)	−0.0358 (1.58)
Constant term	0.1566 (3.06)***	0.2151 (2.50)**	−0.0296 (0.28)
Food and beverages	–	–	–
Textiles	0.1178 (3.62)***	0.1051 (2.46)**	−0.0062 (0.06)
Pulp and paper products	0.1761 (4.51)***	0.0821 (1.34)	0.1116 (1.01)
Chemicals	0.4336 (14.7)***	0.3770 (8.35)***	0.6229 (11.4)***
Petroleum and coal	0.9799 (26.1)***	0.9318 (17.6)***	1.1744 (15.6)***
Non-metallic mineral	0.2963 (9.92)***	0.2584 (5.77)***	0.2453 (3.48)***
Iron and steel	0.5384 (15.3)***	0.4612 (8.66)***	0.4396 (4.69)***
Non-ferrous metals	0.5016 (16.5)***	0.4404 (9.63)***	0.4093 (4.46)***
Fabricated metal products	0.1074 (4.41)***	0.0662 (1.94)*	0.0533 (1.37)
Machinery	0.2292 (10.8)***	0.1767 (5.53)***	0.2548 (8.33)***
Electrical machinery	0.5986 (24.6)***	0.3727 (11.0)***	0.6116 (19.8)***
Transport equipment	0.6044 (27.4)***	0.4809 (19.0)***	0.5711 (24.6)***
Precision instruments	0.4721 (19.5)***	0.4338 (11.3)***	0.3942 (12.7)***
Miscellaneous	0.1247 (5.60)***	0.0875 (2.92)***	0.1289 (4.75)***
$\bar{R}^2$/Se	0.9232, 0.0817	0.9263, 0.0810	0.9636, 0.0472
N	852	493	359
Large customers			
LIQ_{iL}	0.0358 (0.18)	0.0846 (0.24)	−0.6151 (1.57)
LIQ_{iS}	−0.0874 (0.79)	−0.0629 (0.17)	−0.1808 (2.35)**
DEBTSR_{iL}	−0.1271 (2.20)**	−0.1285 (1.30)	0.1334 (0.95)
DEBTSR_{iS}	0.0164 (0.25)	−0.2111 (1.31)	0.1940 (2.80)***
LEND_{iL}	−0.0003 (0.43)	−0.0005 (0.45)	0.0038 (4.31)***
LEND_{iS}	−0.0001 (0.10)	0.0005 (0.32)	−0.0047 (3.61)***
$\mathrm{SGROWTH}_{iL}$	0.1735 (2.73)***	0.0731 (0.94)	0.2870 (2.62)***
$\mathrm{SGROWTH}_{iS}$	0.0072 (0.36)	0.0255 (0.67)	0.0513 (2.61)***
LIQ_{jL}	0.1067 (0.57)	0.3514 (1.11)	0.1400 (0.64)
DEBTSR_{jL}	−0.0530 (0.96)	0.0589 (0.63)	−0.0486 (0.63)
LEND_{jL}	−0.0004 (0.92)	−0.0001 (0.09)	0.0001 (0.20)
$\mathrm{SGROWTH}_{jL}$	−0.1539 (2.39)**	−0.1792 (2.35)**	0.0156 (0.17)
$D1985$	0.0105 (0.25)	0.0000 (0.00)	
$D1990$	−0.0438 (1.85)*	−0.0347 (0.88)	

(*Continued*)

TABLE 2. Continued.

	(1) 1980–2000	(2) 1980–1990	(3) 1995–2000
*D*1995	−0.0112 (0.28)		
*D*2000	−0.0232 (0.79)		−0.0109 (0.67)
Constant term	0.2241 (4.08)***	0.2732 (3.23)***	−0.0434 (0.49)
Food and beverages	–	–	–
Textiles	0.0830 (2.48)**	0.0782 (1.79)*	−0.0627 (0.81)
Pulp and paper products	0.1920 (5.16)***	0.1604 (2.72)***	0.0759 (0.97)
Chemicals	0.4225 (13.8)***	0.3985 (8.50)***	0.4950 (12.0)***
Petroleum and coal	0.9220 (23.5)***	0.8763 (15.7)***	1.0213 (17.9)***
Non-metallic mineral	0.3582 (11.6)***	0.3508 (7.57)***	0.2690 (5.06)***
Iron and steel	0.4147 (12.4)***	0.4026 (7.80)***	0.2923 (4.54)***
Non-ferrous metals	0.5053 (14.6)***	0.4748 (9.15)***	0.3664 (4.91)***
Fabricated metal products	0.0912 (3.62)***	0.0692 (1.95)*	0.0377 (1.29)
Machinery	0.2574 (10.8)***	0.2405 (6.67)***	0.2479 (9.88)***
Electrical machinery	0.5994 (24.2)***	0.4582 (11.9)***	0.6328 (27.4)***
Transport equipment	0.6231 (27.6)***	0.5767 (20.7)***	0.5841 (35.1)***
Precision instruments	0.4837 (19.4)***	0.4666 (11.7)***	0.4341 (18.6)***
Miscellaneous	0.1299 (5.63)***	0.1014 (3.27)***	0.1260 (6.27)***
$\bar{R}^2$/Se	0.9173, 0.0855	0.9191, 0.0856	0.9849, 0.0360
N	866	503	363

Notes: The figures given within the parentheses are the *t*-values in absolute value. $\bar{R}^2$, Se and *N* are the coefficients of determination adjusted for the degree of freedom, standard error of the regression and the number of observations, respectively.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

large suppliers, which warrants stable supply of intermediate goods to customers, makes small customers more dependent on large suppliers.[17]

Now, we turn to the estimation results for large customers. When the estimation is conducted for the whole period, the debt–sales ratio of large suppliers has a significantly negative effect on the proportion of purchases from large suppliers. In the latter period, we find that higher sales growth of large suppliers, lower liquidity of small suppliers and higher debt–sales ratio of small suppliers significantly increase the dependence on large suppliers. We also find that an easier lending attitude toward large suppliers and/or a tighter lending attitude toward small suppliers increase the dependence on large suppliers significantly. This result indicates that the redistributional view of trade credit is valid, even for large firms in the lost decade.

It should be noted that the market structure of suppliers, shown in the bottom panel of the table, is important, irrespective of the sample period and the type of customer. The figures given in the table measure the magnitude of the industry effect, relative to the food products and beverages industry. Almost all the parameter estimates are significantly positive. We observe large values for the petroleum and coal products, electrical machinery and transport equipment industries.

[17] Significantly positive coefficient of sales growth of small suppliers is a bit of a puzzling result to interpret. It might suggest that purchases from small and large suppliers are complements rather than substitutes.

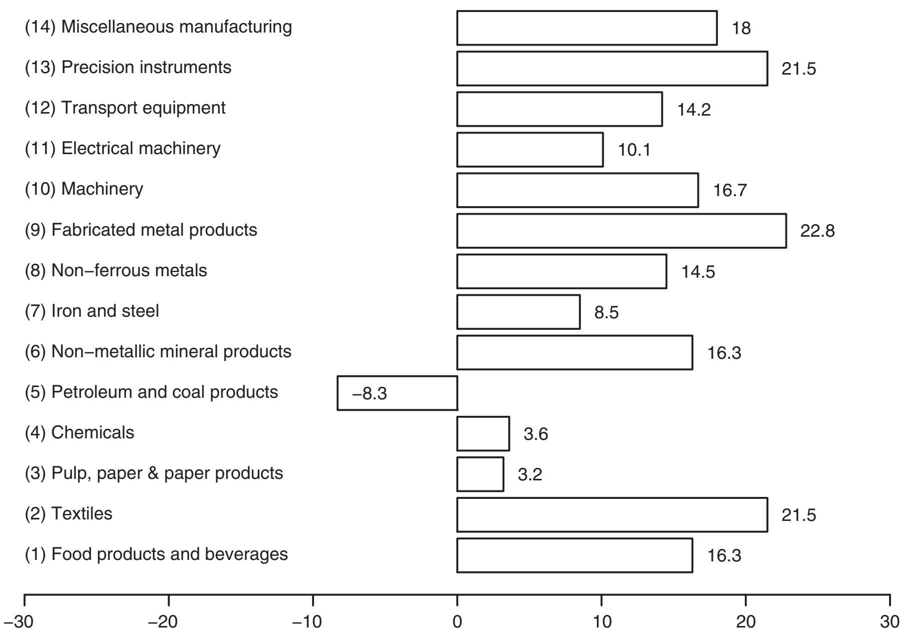
5. THE IMPACT OF BALANCE SHEET CONTAGION ON SECTORAL OUTPUT BY INTER-INDUSTRY LINKAGE: SIMULATION ANALYSIS

The virtue of input–output analysis is that it enables us to quantitatively evaluate to what extent an initial increase in final demand in one sector is propagated into output in other sectors and eventually in aggregate output. This is well known as the multiplier effect. The inverse matrix of identity matrix minus input coefficient matrix plays a vital role in determining the magnitude of multipliers. In the previous sections, we showed that when firm size is taken into consideration in the inter-industry transactions, the input–output coefficients are not technically determined constant, but depend on the balance sheet conditions of firms and financial institutions. The upshot is that the multiplier effects are also affected by the balance sheet conditions of firms and financial institutions. Furthermore, a change in the balance sheet conditions also brings about sectoral reallocation of outputs through substitution of intermediate inputs between large and small firm sector.

In this section, we quantitatively evaluate to what extent sectoral outputs are affected by a change in the balance sheet conditions. Specifically, we conduct the following simulation exercise. It has been often argued that small firms suffered most in the credit crunch in the late 1990s in Japan. Figure 1 shows the difference in the lending attitudes toward large firms and small firms in 1995 by industry. Note that the lending attitude is much easier toward large firms except for petroleum and coal products. In particular, the lending attitude is easier toward large firms by more than 20 percentage points for textiles, fabricated metal products and precision instruments.

We quantitatively evaluate the situation where the lending attitude toward small firms gets easier. Specifically, we assume that the lending attitude of financial institutions toward small

FIGURE 1. Difference in the lending attitude of financial institutions between large firms and small firms.



firms in 1995 gets as easy as that toward large firms across all manufacturing industries, keeping the lending attitude toward large firms intact.[18,19]

In this simulation, we adopt the estimated equations for the period 1995–2000 in Table 2. The impact of this scenario on sectoral output in 1995 is calculated in the following steps. First, we compute the input–output coefficient matrix of the base case in 1995, using the predicted values of $m_{iL,jS}$ and $m_{iL,jL}$, from Equations 13 and 14, by substituting the historical values in 1995 into each explanatory variable.[20] In other words,

$$\begin{aligned} \hat{a}_{iL,jS} &= b_{i,jS}\hat{m}_{iL,jS}, \\ \hat{a}_{iS,jS} &= b_{i,jS}(1-\hat{m}_{iL,jS}), \\ \hat{a}_{iL,jL} &= b_{i,jL}\hat{m}_{iL,jL}, \\ \text{and}\quad \hat{a}_{iS,jL} &= b_{i,jL}(1-\hat{m}_{iL,jL}), \end{aligned} \tag{15}$$

where $\hat{m}_{iL,jS}$ is the predicted value of $m_{iL,jS}$ in 1995 computed from Equation 13, $\hat{m}_{iL,jL}$ the predicted value of $m_{iL,jL}$ in 1995 computed from Equation 14, $b_{i,jS} = p_{M_i}M_{i,jS}/p_jY_{jS}$ the actual ratio of input from the ith industry to output of small firms in the jth industry in 1995 and $b_{i,jL} = p_{M_i}M_{i,jL}/p_jY_{jL}$ the actual ratio of input from the ith industry to output of large firms in the jth industry in 1995.

Then, we calculate the inverse matrix of $\mathbf{I} - (\mathbf{I} - \mathbf{V})\hat{\mathbf{A}}$, where the elements of $\hat{\mathbf{A}}$ matrix are given by Equation 15, and $\mathbf{V}$ is a diagonal matrix where the diagonal elements are the ratios of import to the domestic demand for the corresponding industries.[21]

In the next step, we compute the input–output coefficient matrix under this scenario, by substituting the newly assumed values of the lending attitude variable in $\hat{m}_{iL,jS}$ and $\hat{m}_{iL,jL}$ equation, with the other variables taking the same values as before. We denote the input–output coefficient matrix thus calculated by $\tilde{\mathbf{A}}$. The change in sectoral outputs induced by the domestic final demand is the element of $[\mathbf{I} - (\mathbf{I} - \mathbf{V})\tilde{\mathbf{A}}]^{-1}(\mathbf{I} - \mathbf{V})\mathbf{f^d}$.

The change in sectoral outputs is composed of two parts. One is the change in sectoral outputs due to the change in the input–output coefficient matrix. This part is calculated as

$$[[\mathbf{I} - (\mathbf{I} - \mathbf{V})\tilde{\mathbf{A}}]^{-1} - [\mathbf{I} - (\mathbf{I} - \mathbf{V})\hat{\mathbf{A}}]^{-1}][(\mathbf{I} - \mathbf{V})\mathbf{f^d} + \mathbf{e}], \tag{16}$$

where $\mathbf{f^d}$ is the domestic final demand vector, including private consumption, private investment, inventory change and government expenditure, and $\mathbf{e}$ is the vector of export in 1995. This term reflects the substitution of intermediate inputs between small firms and large firms.

The other part is the change in sectoral outputs induced by a change in the final demand. Note that the change in the balance sheet conditions of firms and financial institutions

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[18] Note that in this scenario, the lending attitude of financial institutions toward small firms tightens in petroleum and coal products.

[19] An easier lending attitude toward small firms might be made possible by adopting special credit guarantee programs for small businesses.

[20] For the predicted year, 1995, the mean absolute error of $\hat{m}_{iL,jl}$ is 0.0206 for small firms ($l = S$) and it is 0.0171 for large firms ($l = L$). In terms of the original input coefficients, $\hat{a}_{iL,jl} = b_{i,jl}\hat{m}_{iL,jl}$ used for the simulation, the mean absolute errors are negligibly small: 0.00064 for small firms and 0.00049 for large firms.

[21] The predicted $\hat{m}_{iL,jl}$ ($l = S, L$) can exceed unity or take a negative value. This case is quite likely when actual $m_{iL,jl}$ is very close to unity or zero, since our prediction is based on OLS with a fixed-effects model. Actually, we have 10 ($\hat{m}_{iL,jS} > 1$) and 1 ($\hat{m}_{iL,jS} < 0$) cases out of 179 observations for small firms and 10 ($\hat{m}_{iL,jL} > 1$) and 2 ($\hat{m}_{iL,jL} < 0$) cases out of 182 observations for large firms. In these cases, we replace them with 1 or 0.

might affect investment, an important component of domestic final demand.[22] This part is written as

$$[\mathbf{I} - (\mathbf{I} - \mathbf{V})\tilde{\mathbf{A}}]^{-1}(\mathbf{I} - \mathbf{V})\Delta\mathbf{f^d}, \tag{17}$$

where $\Delta\mathbf{f^d}$ is the change in the domestic final demand in 1995 arising from the change in balance sheet conditions.

Now, we turn to the quantitative evaluation of the scenario. The first column in Table 3 reports the sectoral output before the change in the lending attitude of financial institutions, calculated as $[\mathbf{I} - (\mathbf{I} - \mathbf{V})\hat{\mathbf{A}}]^{-1}[(\mathbf{I} - \mathbf{V})\mathbf{f^d} + \mathbf{e}]$. The second column reports the sectoral output after the change in the lending attitude, calculated as $[\mathbf{I} - (\mathbf{I} - \mathbf{V})\tilde{\mathbf{A}}]^{-1}[(\mathbf{I} - \mathbf{V})\mathbf{f^d} + \mathbf{e}]$. The third column is the difference between the second column and the first one. The figures given in the third column represent how much the output of a certain industry changes when the lending attitude toward small firms gets as easy as that toward large firms, with the final demand being fixed.

As for the change in the final demand, based on the investment function estimated in Ogawa (2003b), an easing lending attitude toward small firms in this scenario increases corporate investment of small firms by 682.6 billion yen. This increase in investment is then allocated across industries, using the weights of the private gross fixed capital formation by industry in 1995. The fourth column reports the increase in sectoral outputs brought about by this increment in the final demand. The fifth column reports the total change in sectoral outputs, sum of the third column and the fourth one. The sixth column reports the rate of change in sectoral outputs.

The table also reports the grand total of the figures over large firms in manufacturing industries and that over small firms in manufacturing industries. The former corresponds to the total increase in the output of large firms in all manufacturing industries, while the latter corresponds to that in the output of small firms in all manufacturing industries.

The third column in Table 3 reports that the output of small manufacturing firms increases by 8,310.5 billion yen and that of large manufacturing firms decreases by 8,986.6 billion yen. The output of the manufacturing firms as a whole decreases by 676.1 billion yen. This indicates that intermediate inputs purchased from large manufacturing firms are substituted by those purchased from small manufacturing firms that now face a lending attitude as favorable as that faced by large firms.

Induced by an increase in the final demand, the output of small and large manufacturing firms is raised by 281.6 billion yen and 280.4 billion yen, respectively. Comparison of the third column with the fourth one shows that substitution effects dominate the multiplier effects. Consequently, the output of small manufacturing firms increases by 8,592.1 billion yen, while that of large manufacturing firms decreases by 8,706.2 billion yen. The change in output varies across industries. In large manufacturing firms, the change is notably large for textile (−86.9%) and fabricated metal products (−20.6%). On the other hand, in small manufacturing firms, the change is large for iron and steel (20.8%), non-ferrous metals (17.9%), transport equipment (14.8%) and textile (14.3%).

Figure 2 shows the scatter diagram of the rate of change in output of small manufacturing firms and the change in the lending attitude of financial institutions toward small firms across

[22] For example, see Ogawa (2003b) for the effects of balance sheet conditions of firms and financial institutions on corporate investment.

TABLE 3. Effect on sectoral outputs.

			(1)[a]	(2)[b]	(3): (2) − (1)	(4)[c]	(5): (3) + (4)	(6): (5)/(1)	(7)[d]
(1)	Agriculture		15,808.3	15,913.1	104.9	6.2	111.0	0.7	6.1
(2)	Mining		1,660.7	1,653.3	−7.4	2.6	−4.8	−0.3	2.6
(3)	Food and beverages	Large	8,460.0	8,068.0	−392.1	1.0	−391.1	−4.6	1.0
(4)		Small	30,395.6	30,773.7	378.2	5.1	383.3	1.3	5.1
(5)	Textile	Large	423.7	55.5	−368.2	0.0	−368.2	−86.9	0.5
(6)		Small	3,626.0	4,138.0	511.9	5.7	517.6	14.3	4.9
(7)	Pulp and paper	Large	2,920.5	2,735.6	−184.9	3.1	−181.8	−6.2	3.4
(8)		Small	6,498.4	6,606.6	108.2	7.4	115.6	1.8	7.3
(9)	Chemicals	Large	13,385.1	13,036.2	−348.9	8.2	−340.7	−2.5	8.6
(10)		Small	12,405.1	12,688.0	282.9	9.4	292.3	2.4	9.1
(11)	Petroleum and coal	Large	9,921.9	9,937.6	15.7	9.5	25.1	0.3	9.5
(12)		Small	566.8	525.8	−40.9	1.7	−39.2	−6.9	1.8
(13)	Non-metallic mineral	Large	1,787.5	1,480.2	−307.3	3.0	−304.3	−17.0	3.7
(14)		Small	7,908.2	8,229.6	321.4	24.0	345.4	4.4	23.3
(15)	Iron and steel	Large	15,350.1	14,390.2	−959.8	35.9	−923.9	−6.0	38.5
(16)		Small	4,769.3	5,746.1	976.9	15.3	992.1	20.8	12.6
(17)	Non-ferrous metals	Large	3,705.8	3,227.7	−478.1	7.6	−470.5	−12.7	8.7
(18)		Small	2,643.2	3,109.9	466.7	6.1	472.8	17.9	5.0
(19)	Fabricated metal	Large	3,669.2	2,902.5	−766.7	9.4	−757.3	−20.6	11.1
(20)		Small	12,042.9	12,807.2	764.2	35.6	799.8	6.6	33.9
(21)	Machinery	Large	13,820.6	13,134.7	−685.8	51.6	−634.3	−4.6	54.1
(22)		Small	14,657.0	15,329.2	672.2	62.4	734.6	5.0	60.0
(23)	Electrical machinery	Large	36,428.4	35,421.7	−1,006.6	78.4	−928.2	−2.5	80.8
(24)		Small	13,949.2	14,839.4	890.2	35.2	925.4	6.6	33.1
(25)	Transport equipment	Large	33,616.1	32,096.8	−1,519.4	59.1	−1,460.2	−4.3	61.9
(26)		Small	8,171.9	9,363.4	1,191.5	16.7	1,208.2	14.8	14.5
(27)	Precision instruments	Large	1,786.8	1,713.2	−73.6	3.1	−70.5	−3.9	3.3
(28)		Small	2,023.8	2,096.8	73.0	4.9	77.9	3.8	4.7
(29)	Miscellaneous	Large	11,390.8	9,480.0	−1,910.7	10.5	−1,900.3	−16.7	13.5
(30)		Small	36,211.3	37,925.4	1,714.1	52.1	1,766.2	4.9	49.4

(*Continued*)

TABLE 3. Continued.

			$(1)^a$	$(2)^b$	(3): (2) − (1)	$(4)^c$	(5): (3) + (4)	(6): (5)/(1)	$(7)^d$
(31)	Construction		88,149.9	88,150.9	1.0	323.9	324.9	0.4	323.9
(32)	Electricity		26,462.5	26,439.5	−23.0	20.4	−2.6	0.0	20.4
(33)	Wholesales and retails	Large	52,112.4	52,126.0	13.6	64.6	78.1	0.1	64.6
(34)		Small	50,212.3	50,250.1	37.8	62.6	100.4	0.2	62.5
(35)	Finance		100,521.3	100,526.4	5.1	44.1	49.2	0.0	44.1
(36)	Transportation		55,666.3	55,669.6	3.2	49.4	52.6	0.1	49.4
(37)	Service	Large	37,647.7	37,613.5	−34.2	56.0	21.8	0.1	56.1
(38)		Small	79,222.4	79,192.6	−29.9	68.9	39.0	0.0	68.9
(39)	Public administration		100,351.7	100,293.3	−58.3	21.6	−36.8	0.0	21.7
(40)	Unclassified		7,555.7	7,559.8	4.1	9.3	13.3	0.2	9.2
(41)	Large manufacturing		156,666.5	147,679.9	−8,986.6	280.4	−8,706.2	−5.6	298.5
(42)	Small manufacturing		155,868.6	164,179.1	8,310.5	281.6	8,592.1	5.5	264.8
(43)	Manufacturing total		312,535.1	311,859.1	−676.1	562.0	−114.1	0.0	563.3
(44)	Industry total		927,906.4	927,247.1	−659.3	1,291.3	632.1	0.1	1,292.9

Note: Unit: billions of yen for columns (1)–(5) and (7); % for column (6).

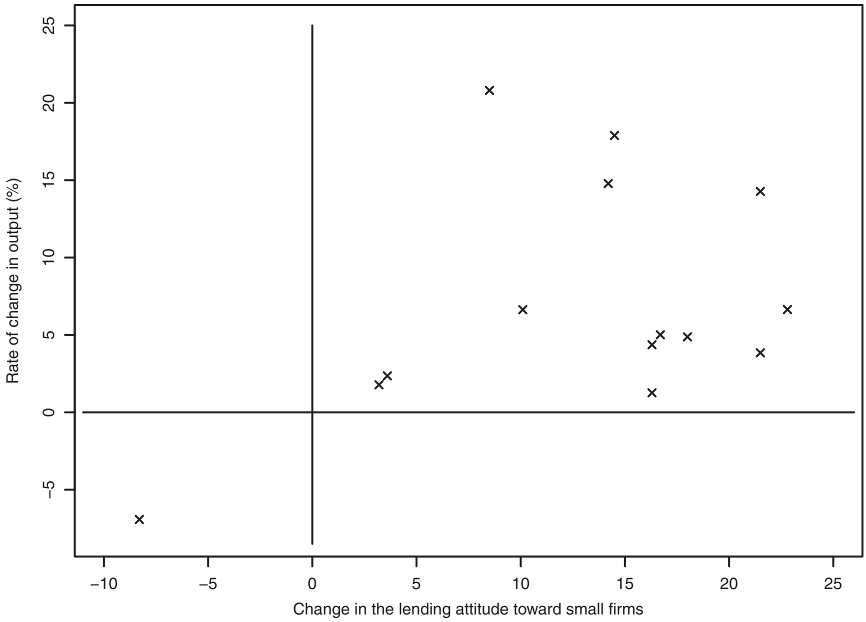
$^a[\mathbf{I} - (\mathbf{I} - \mathbf{V})\hat{\mathbf{A}}]^{-1}[(\mathbf{I} - \mathbf{V})\mathbf{f^d} + \mathbf{e}]$.

$^b[\mathbf{I} - (\mathbf{I} - \mathbf{V})\tilde{\mathbf{A}}]^{-1}[(\mathbf{I} - \mathbf{V})\mathbf{f^d} + \mathbf{e}]$.

$^c[\mathbf{I} - (\mathbf{I} - \mathbf{V})\tilde{\mathbf{A}}]^{-1}(\mathbf{I} - \mathbf{V})\Delta\mathbf{f^d}$.

$^d[\mathbf{I} - (\mathbf{I} - \mathbf{V})\hat{\mathbf{A}}]^{-1}(\mathbf{I} - \mathbf{V})\Delta\mathbf{f^d}$.

FIGURE 2. Relationship between the rate of change in output and the change in the lending attitude across industries: small manufacturing firms.



industries. We observe a positive correlation of the rate of change in the lending attitude with the rate of change in output.[23] In fact, the correlation coefficient is 0.41.

Our approach is contrasted with the conventional one. In the conventional approach, a favorable change in the lending attitude toward small firms is analyzed as follows. As shown above, a favorable change in the lending attitude toward small firms creates 682.6 billion yen increase in corporate investment, which is allocated across industries as additional final demand, using the weights of the private gross fixed capital formation by industry in 1995. Then, the multiplier is calculated based on the input–output coefficient matrix without taking account of the effects of change in the lending attitude. Change in output thus calculated is given in the seventh column of Table 3. Comparison of the fifth column and the seventh one shows that the change in output is overestimated for large manufacturing firms and underestimated for small manufacturing firms in the conventional approach. This is due to the omission of substitution effects of intermediate inputs from large manufacturing firms to small manufacturing firms in the conventional approach. The total multiplier is also quite different between the two approaches. The multiplier in our approach is 0.926 (=632.1/682.6), while it is 1.894 (=1,292.9/682.6) in the conventional case.

The simulation results given above indicate the quantitative importance of substitution effects of intermediate inputs between large and small manufacturing firms. Furthermore,

[23] In this simulation, we cannot tell whether bank credit is indeed extended toward small firms under an easier lending attitude toward small firms. If it is the case, then the risk of credit might be borne out by the government under the credit guarantee program for small businesses.

substitution of intermediate inputs between large and small manufacturing firms might be triggered by change in the lending attitude toward the small firm sector.

6. CONCLUDING REMARKS

This paper proposed a novel approach to investigating the propagation mechanism of balance sheet deterioration in financial institutions and firms, by extending the conventional input–output analysis. The direction of extension is twofold. One is the use of input–output tables that are classified by firm size for the manufacturing sector. This adds another dimension to the inter-industry structure: the transactional relationship between firms of different sizes. The other links the input–output tables with the balance sheet conditions of financial institutions and firms, and this enables us to analyze customers' decision-making in allocating input purchases between large and small suppliers.

By pooling the Japanese input–output tables, classified by firms, for 1980, 1885, 1990, 1995 and 2000, we explored the determinants of the purchase of intermediate goods from large and small suppliers. We found that the lending attitude of financial institutions affected customers' input decisions from the late 1990s to the early 2000s when the financial system suffered from dysfunction due to massive non-performing loans.

Based on the estimation results, we conducted simulation exercises to quantitatively evaluate the extent to which the change in the balance sheet conditions of financial institutions that was favorable to small firms affected the sectoral outputs. We found that the output increased for small firms and declined for large firms. The change in output was non-negligible, about 5.5% of the initial output of each sector. In particular, it exceeded 20% in textile, iron and steel and fabricated metal products. This suggests that a change in the balance sheet conditions of financial institutions generates a non-negligible distributional change in output among firms of different sizes during financial crises when small firms have a difficulty in raising funds.

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