

The Effects of Financial Support Policies on Corporate Decisions by SMEs[†]

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This paper investigates the effectiveness of public credit guarantee programs and interest-support programs for SMEs (small and medium enterprises). First, assuming that there is an imperfect information structure in the SME loan market, we analyze how SME support financial programs affect the corporate decisions made by SMEs with regard to default or loan sizes. In addition, this paper theoretically computes the optimal levels of credit guarantee amounts and the interest-support spread under equilibrium with imperfect information in a competitive loan market. Second, the paper empirically analyzes the continuous policy-treatment effect with the GPS (generalized propensity score) method. In particular, we consider the ratio of guaranteed debt to the total debt as a continuous policy treatment. The empirical results show that marginal effects of a credit guarantee on SMEs' productivity, profitability, and growth potential decrease with the ratio of guaranteed debt to the total debt. In addition, the average effect of a credit guarantee is maximized when this ratio is at 50% to 60%.

Key Word: Small and Medium-sized Enterprises,
Information Asymmetry, Loan Market,
Credit Guarantee, Generalized Propensity Score
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I. Introduction

Recently, concerns have been raised that financial support for Korean SMEs could delay the restructuring of SMEs and reduce the productivity of the Korean economy overall despite the fact that the Constitution of the Republic of

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Korea guarantees the incubation and training of Korean SMEs. The magnitude of public credit guarantees compared to the economy is relatively large as compared to that in other OECD countries. In fact, this issue has been constantly raised, but studies that develop theoretical models about financial friction in relation to limited financing for SMEs are rare. Stiglitz and Weiss (1981) in their partial equilibrium model for the SME loan market show the possibility of the existence of credit allocation (credit rationing). However, they do not provide a balanced model of the SME lending market which reflects policy effects on production and consumption in the economy to provide a basis that can be comprehensively judged by policymakers.

This study seeks to identify the optimal level of SME financing policies by simulating how corporate decision-making, including bankruptcy decisions and bank interest rate decisions in the lending market, can be affected by government finance policies (public credit guarantees and interest support) in the presence of information asymmetry (imperfect information) for SMEs, a balanced fiscal policy, and the current tax regime. The basic purpose of SME financing policies is to alleviate financial friction and information asymmetry in order to realize the optimal allocation of resources. However, the existence of information asymmetry leads to a fiscal policy under which consumers should pay taxes for SMEs. Therefore, the amount of macro-financial assistance is determined at an optimal combination of income taxes paid by small businesses and final consumers.

Moreover, this paper proposes more concrete policy measures to improve the credit guarantee policy on the basis of the presented theoretical discussions, in particular by analyzing the performances of SMEs. Previous studies focused mainly on exposure (or a lack of it) to credit guarantee policies rather than on the impact of the degree of exposure to a credit guarantee policy on the performance of SMEs. Therefore, this study empirically examines the effect of the ratio of guaranteed debt to total debt as a continuous policy treatment on SME performance outcomes with the GPS (generalized propensity score) method.

Briefly, this study finds the following. The equilibrium model based on bankruptcy and lending decisions by SMEs shows that the current scale of public credit guarantees is higher than the optimal level of policies because the social cost is beyond the optimal level. This suggests that the government should consider gradually reducing the amount of public credit guarantees to maximize social welfare. Second, the performance analysis shows that the marginal effect of credit guarantee policies on their ratio of credit-guaranteed debt to total debt is decreasing for the SMEs. This suggests that it is necessary to limit the ratio of credit guarantees to total debt.

This paper is organized as follows. Section II describes the current status of SME financial support programs and compares with other country-specific financial support policies in OECD countries. Section III develops the equilibrium model and Section IV conducts a social welfare analysis in accordance with a counter-factual economic model. Section V analyzes the policy effects of the credit guarantee program with firm-level data. Finally, Section VI proposes directions for improvement of the financial support programs for SMEs.

II. SME Financial Policies

A. Credit Guarantee and Interest Support Programs

A public credit guarantee refers to a type of financial support program for SMEs that deficient collateral capacity. It offers a warranty for payment to banks upon the bankruptcy or liquidation of the borrowing SME. This program offers a higher degree of financial support in terms of the policy scale, and is typical of SME financing policies. Regarding the overall amount of Korean public credit guarantee funding, KODIT,¹ KIBO,² and KOREG³ recorded a value of 75.5 trillion won at the end of 2013, which accounted for 15.4% of all SME loans, i.e., 488.9 trillion won. Compared with 2007 before the global financial crisis, the magnitude of public credit guarantees has increased by nearly 70%.

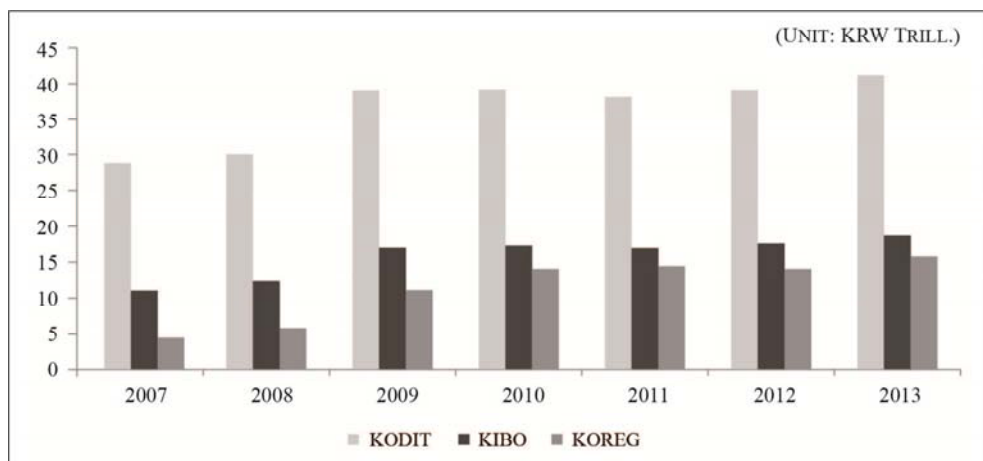


FIGURE 1. TRENDS OF CREDIT GUARANTEE PROGRAMS

TABLE 1—CREDITS FOR INDEMNIFICATION OF KODIT (UNIT: KRW TRILL., %)

	2007	2008	2009	2010	2011	2012	2013
Guaranteed Loans	28.5	30.3	39.2	38.7	38.4	39.2	40.6
Subrogation	1.1	1.4	1.8	1.8	1.9	1.9	1.7
(Subrogation Rate)	4.1	4.8	4.7	4.7	5.0	4.9	4.4
Indemnity	3.1	3.1	3.0	2.9	3.0	3.2	3.3
Recovered Credits	0.6	0.6	0.7	0.8	0.7	0.7	0.5
Recovery Rate	17.2	18.8	23.1	25.8	24.5	23.5	16.6

Note: we use average amounts per year to compute the subrogation and recovery rates.

¹Korea Credit Guarantee Fund.

²Korea Technology Finance Corporation.

³Korea Federation of Credit Guarantee Foundations.

Credit guarantee institutions subrogate payments of bankrupt SMEs to lenders and obtain indemnity from bankrupt SMEs. KODIT (the Korea Credit Guarantee Fund) had an average subrogation rate of 4.7% from 2007 to 2013, and its average recovery rate of credits for indemnification was 21.3%. However, the average recovery rate of commercial banks is approximately 25%, implying that public credit guarantee funds may be more benevolent than the private sector.

An interest-support program means a financial policy that provides SMEs with a portion of the loan interest rate when SMEs satisfy certain conditions. The interest-support program is typically implemented by local governments. For example, the Seoul metropolitan government provided SMEs with interest support from 1%p to 3%p according to CD rates, and most local governments, such as the Busan metropolitan government, offer supports ranging from 2%p to 5%p of the interest spread when they lend working capital to small businesses. In recent years, the fiscal expenditures of the central government for interest-support programs appear to be expanding, but it is not clear whether small business loans are actually supported.

In addition, KIBO, as a technology credit bureau, operates an interest-support program offering up to 3%p for credit loans issued. In particular, the 2014 budget of KIBO for this program was 3.75 billion won, which supported nearly 375 billion won of credit loans at an average interest-support spread of 1%p.

B. Policy Comparison with OECD Countries

Given the recent doubts about the economic efficiency of public credit guarantee programs, how much the government should provide public credit guarantees is at issue. In particular, the amounts of SME loans and the sizes of public credit guarantees in OECD countries are very important references in setting policy goals.

Table 2 shows the proportions of SME loans to all business loans in OECD countries. Korean SME loans held a ratio of 74.7% of all business loans in 2012, but exceeded 80% of all business loans from 2007 to 2010. SME loans in most other countries accounted for no more than 50% of all business loans, except in Portugal and Switzerland, which recorded similar levels, at 74.7% and 78.8%, respectively, in 2012.

TABLE 2—SME LOANS OVER BUSINESS LOANS OF OECD COUNTRIES (UNIT: %)

	2007	2008	2009	2010	2011	2012
Canada	17.4	15.6	17.9	17.5	17.5	15.7
Chile	16.7	15.2	17.5	18.2	18.2	18.5
Korea	86.8	82.6	83.5	81.5	77.7	74.7
Mexico	13.0	12.3	12.0	13.0	13.4	16.1
Portugal	78.3	77.7	77.4	77.3	77.1	74.7
Switzerland	81.2	81.1	80.1	79.9	78.8	78.8
Turkey	40.1	33.8	31.7	35.6	35.7	37.5
U.K.	19.6	18.0	19.9	21.2	21.2	21.8
U.S.A	30.1	27.7	27.6	29.0	26.5	23.7

Note: OECD, Financing SMEs and Entrepreneurs 2014: An OECD Scoreboard.

TABLE 3—GUARANTEED LOANS OVER SME LOANS OF OECD COUNTRIES (UNIT: %)

	2007	2008	2009	2010	2011	2012
Canada	1.4	1.6	1.4	1.5	1.4	1.3
Chile	3.0	2.5	6.5	10.2	9.4	15.0
Finland	3.6	3.7	4.8	5.4	6.3	5.2
Korea	12.0	11.6	15.2	16.0	15.4	15.4
Mexico	0.9	1.1	1.9	1.9	2.1	1.6
Netherland	1.9	1.9	2.4	5.7	5.4	3.2
Portugal	0.9	1.7	5.3	7.4	6.9	7.2
Spain	1.3	2.0	2.2	3.4	4.3	3.4
Switzerland	0.0	0.0	0.1	0.1	0.1	0.1
Turkey	0.1	0.3	0.7	0.7	0.7	0.6
U.K.	0.2	0.2	0.7	0.5	0.3	0.3
U.S.A.	3.0	2.3	2.2	3.4	3.1	3.9

Note: OECD, Financing SMEs and Entrepreneurs 2014: An OECD Scoreboard.

Table 3 shows the shares of SME loan credit guarantees of SME loans in OECD countries. The table also shows that Korea has the highest proportion of public credit guarantees of SME loans among OECD countries, followed by Chile, which guaranteed 15% of SME loans during the financial crisis.

However, Portugal and Switzerland recorded SME loans of 7.2% and 0.1%, respectively, at the end of 2012, showing relatively low rates compared to Korea. In addition, the table confirms that public credit guarantees in developed countries such as Canada, the United Kingdom, and the United States do not exceed 5% of all SME loans. Additionally, in developed countries, capital market financing is more accessible than loan financing to SMEs; therefore, the intervention of those governments in the loan markets is less likely to occur than in other countries.

III. Equilibrium in the SME Loan Market

A. Theory of the SME Loan Market with Imperfect Information

It has been a long time since the issue of corporate lending through financial intermediation, particularly the SME loan market with information asymmetry, has been discussed. Stiglitz and Weiss (1981) reviewed the possibility of credit rationing as provoked by information asymmetry. Specifically, a single collateral rate and a single loan interest rate in the economy were presented in their work and demonstrated to distort the supply curve of SME loans through adverse selection, with the supply curve not increasing monotonically at a certain level of interest rate because SMEs with riskless businesses exit the loan market, whereas SMEs running risky businesses stay in the loan market. Eventually banks offer interest rates that lead to excess demand such that the credit rationing by the government can exist.

This argument is quite controversial, and the possibility of credit rationing is refuted in various papers as a result. Typical papers taking this line include Bester (1986) and Arnold and Riley (2009). Bester (1986) argued that credit assignment occurred in the economy of Stiglitz and Weiss (1981) due to the single-rate loans with a single collateral rate. If a bank can offer various sets of collateral rates and

interest rates, the loan market can identify the riskiness of medium and small businesses and thus provide several financial products with different collateral rates and interest rates. In other words, the bank can offer a wide range of loan products with collateral requirements and interest rates and can force companies to reveal their degree of riskiness.

Arnold and Riley (2009) contradict the possible existence of credit rationing using the same economic structure in Stiglitz and Weiss (1981). They argue that credit rationing may occur due to a disconnection in the demand curve rather than an issue with the supply curve, as in Stiglitz and Weiss (1981). If the bank revenue curve shows a U-shaped line, the optimal curve of the interest rate to maximize a bank's expected return will have a disconnection at a certain point, at which demand exceeds supply. However, Arnold and Riley (2009) explain that this is likely to arise only when the tail distribution of a low-risk business is extremely low. Recently, however, Nam (2013a) demonstrated the possibility of credit rationing by calculating invariant measures of SMEs in a repeated game structure with bankruptcy decisions. We essentially utilize the economic structure of Stiglitz and Weiss (1981). However, there are different assumptions in this paper as compared to those in Stiglitz and Weiss (1981). The government presents a credit guarantee ratio for a loan, and banks offer optimal interest rates to SMEs under imperfect information. Moreover, SMEs determine loan amounts depending on their productivity states, unlike in Stiglitz and Weiss (1981). Finally, the government finances the social cost of credit guarantees by collecting tax on consumer deposits.

Decision-making by firms in the economy is much more complicated than the consumer decision-making structure. First, a company should optimize its capital and investment amounts depending on the current investment opportunities and should determine wage prices and other production factors, including labor. In addition, firms should allocate net income optimally into investments and dividends according to economic conditions and should determine their use of indirect financing or direct financing in their corporate finance strategy.

A few studies of corporate decisions about investments, dividends and corporate finance use the Bellman equation (or dynamic programming). Although many recent studies are notable, the present study mainly references Hopenhayn (1992); Chatterjee, Corbae, Nakajima, and Rios-Rull (2007); and Arellano, Bai, and Zhang (2012).

Hopenhayn (1992) for the first time showed that there is a general equilibrium state in a firm's entry-exit structure, proving that there is an invariant distribution of companies in the market in accordance with the steady-state rates of entry and exit. Chatterjee, Corbae, Nakajima, and Rios-Rull (2007) analyze the social welfare effects of changes in credit policies, especially when consumer debt is not fully guaranteed. Arellano, Bai, and Zhang (2012) demonstrate that the corporate development growth rate and the size of indirect financing depend on the degrees of financial development and financial friction. However, a firm's exit value in the economy is exogenous, as in Hopenhayn (1992), and a firm automatically exits from the market if its operational value is lower than its exit value.

This paper utilizes the economic structure of Hopenhayn (1992). A firm decides to exit the market through bankruptcy, or it can borrow money from a bank, as in

Arellano, Bai, and Zhang (2012). There are financial friction and an adjustment cost of indirect financing. Finally, the present paper calculates the invariant distribution of firm bankruptcies with partial government guarantees, as in Chatterjee, Corbae, Nakajima, and Rios-Rull (2007). One of the main features in this model is that the liquidation value of a SME is determined endogenously such that the firm's entry rate is determined in accordance with its bankruptcy decision.

This paper refers to many earlier works about such dynamic decision models. Zhang (2005); Cooper (2006); Li, Livdan, and Zhang (2009); Nikolov and Whited (2009); and Livdan, Saprizza and Zhang (2009) are the main references. These all posit various dynamic designs of corporate decision models and discuss how they are affected by uncertainty in the macro-economy or by idiosyncratic shocks. In addition, these corporate decision models analyze the impact of dividends and investments on stock prices. In particular, Clementi and Hopenhayn (2006) explain firm dynamics in terms of dynamic contract theory under information asymmetry. However, they do not take into account the distribution of equilibrium among firms, and they only focus on the optimal conditions of contract theory. Moreover, they do not endogenously address market entry and exit rates.

The present model is in general new compared to those in earlier works. First, capital from the loan market is included as an operating profit function, whereas most existing dynamic models separate external financing from production capital. Second, our model endogenizes the default decisions of SMEs such that the firm's default value and entry value are endogenously determined by a default decision. Third, in our model, the government intervenes in the loan market with financial policies such as credit guarantee and interest support programs. Earlier firm dynamic models only consider the relationships between firms and financial institutions and not policy-intervention efforts by the government. Thus, our model is unique in terms of proactive policy intervention in the loan market.

B. SME Dynamic Decision Model

1. Operating Firms' Decisions

The structure of corporate cash flow is defined as

$$\pi(k=1, b, z) = z(k+b)^\alpha,$$

in which π is the operating income function with z as the exogenous shock unknown to the government and banks, as they know only the transition probability of z . Moreover, z is defined as a first-order autoregressive process with i.i.d. shock. In this model, z is the main factor to induce information asymmetry into the SME loan market, k is the capital normalized to one, and b is the loan size that is also the leverage ratio owing to the normalization of capital. α is a parameter which denotes the capital share in the operating income function.

The current operating company, that is, a SME without a credit history of default has dynamic decisions defined as

$$V(b, z, h=0) = \max \begin{cases} V_0(b, z, 0) \equiv \max_{b' \in [0, \bar{b}]} C_0 + \beta E[V(b', z', 0)|z], \\ V_1(b, z, 0) \equiv C_1 + \beta E[V(0, z', 1)|z] \end{cases}$$

in which h is defined as the credit history of default, taking a value of one if a SME became bankrupt in the last period or zero otherwise. C_0 and C_1 are defined as

$$C_0 \equiv \pi - (q - r_g)b + (1 - f_c c)b' - \Phi(b', b), C_1 \equiv \pi 1_{\{z < 0\}} - rc \cdot cb.$$

Here, V is the value of the operating company without a history of default, and V_0 is the value of the operating company when it decides not to default and obtain a new loan, b' , from a bank. V_1 is the firm value of a company that decides to declare bankruptcy at the present time. q and r_g are defined as the loan interest rate and the interest-support spread, respectively. f_c and c are the credit guarantee fee to pay to the government and the coverage ratio of the credit guarantee, respectively. β is a parameter pertaining to the time discount preference, and rc is the recovery rate of credit for indemnification after subrogation of the government instead of a bankrupt company. $E[\cdot|z]$ is the expectation operator given z . $\Phi(b', b)$ is defined as the adjustment cost function of the loan size, as in the equation

$$\Phi(b', b) = \frac{\gamma}{2} (b', b)^2 1_{\{(b' - b) > 0\}},$$

in which γ is a parameter linked to the adjustment cost function, which is represented as a quadratic function in order to prevent companies from borrowing money excessively. Finally, $1_{\{\cdot\}}$ is an indicator function having a value of 1 if the statement in $\{\cdot\}$ is true, and 0 otherwise. The symbol $'$ over the variables denotes the next period. If the firm decides not to declare bankruptcy at the present time, it chooses the optimal size of a loan for the next period, b' , in $[0, \bar{b}]$, and proceeds to the decision of the next period, $V(b', z', 0)$. Moreover, if the firm decides to declare bankruptcy at the present time, the firm should give any positive operating income to the lender and pay the recovery rate multiplied by the guaranteed loan size (cb) back to the government, and then move to $(0, z', 1)$.

2. Bankrupt Firms' Decisions

A firm with a history of default ($h=1$) has the following decision structure,

$$V(0, z, 1) = 0 + \beta(1 - \delta)E[(1 - \lambda)V(0, z', 0) + \lambda V(0, z', 1) | z],$$

in which δ is defined as the probability of business liquidation after bankruptcy, and δ is exogenously given. The cash flow of a bankrupt firm is zero because it is assumed to have ended its operations during its default history. λ is defined as the probability of bank account suspension of the bankrupt company, which is 1/2. In this model, the business liquidation rate and the duration of the default history determine endogenously firms' default rates and entry rates into the market. Therefore, if a firm decides to default in the previous period, then in the present period, the firm stays in the market without operating income, and the firm will close its business in the next period with the probability of δ or will stay in the market with or without a history of default according to the probability⁴ of λ .

3. Firms' Invariant Distributions

The state-mapping function is defined according to the state variable vector, (b, z, h) ,

$$H(b, z, h' = 0) = \begin{cases} 1 & \text{if } d = 0 \text{ and } h = 0 \\ \gamma & \text{if } h = 1 \\ 1 & \text{if } d = 1 \end{cases}$$

$$H(b, z, h' = 1) = \begin{cases} 1 & \text{if } d = 0 \text{ and } h = 0 \\ 1 - \lambda & \text{if } h = 1 \\ 1 & \text{if } d = 1 \end{cases}$$

and the transition function of corporate policy is defined as

$$(1) \quad G(b, z, h' = 0, S) = \oint_z 1_{\{b' \in B\}} H(b, z, h' = 0) f(dz' | z)$$

$$(2) \quad G(b, z, h' = 1, S) = \oint_z 1_{\{b \in B\}} H(b, z, h = 0, h' = 1) f(dz' | z)$$

$$\text{or } \oint_z 1_{\{b=0\}} H(b, z, h = 1, h' = 1) f(dz' | z)$$

in which \oint is the matrix operator, $f(\cdot | \cdot)$ is the transition probability of z , and S is defined as the compact space of the state variables. The entry function of newborn firms is defined as

⁴The Korea Financial Telecommunications & Clearings Institute (KFTCI) suspends the checking accounts of bankrupt companies for investor protection for at least two years.

$$(3) \quad N(b, z, 1, S) = \int_z 1_{\{(b', h') = (0, 0)\}} g(dz'),$$

in which $g(\cdot)$ is the probability of z . Finally, we define the transition function of firm as

$$G^*(b, z, S) = \delta(1 - \lambda)N(b, z, 1, S) + G(b, z, 0, S) + (1 - \delta)G(b, z, 1, S).$$

Additionally, given (c, q) , the distribution of the corporate state-vector (b, z, h) , μ , is defined using the operator Y as

$$(Y_{(c,q)}\mu)(B \times Z) = \int G^*(b, z, S) d\mu$$

| Theorem (Unique Existence of Invariant Measure)

For any $(c, q) \in C \times Q$, and for the measurable selection of the optimal policy correspondence, the unique and invariant distribution $\mu_{(c,q)} \in M(B \times Z, S)$ satisfies $\mu_{(c,q)} = Y_{(c,q)}\mu_{(c,q)}$.

| Proof

We use the proof of Theorem 2 in Chatterjee, Corbae, Nakajima, and Rios-Rull (2007).

Here, μ represents the distribution of default decisions as well as the loan sizes according to the state variables. Specially, μ is defined as banks' belief function with respect to d , b , and z , which are information inaccessible to banks. We can then calculate the default probability and the conditional default probability $\mu(d=1)$ and $\mu(d=1|b)$ (Athreya, Tam, and Young 2012). In addition, $\mu(d=1)$ is the point-mass value because d represents a discrete choice of the default decision.

C. Equilibrium Model

1. Bank Interest Rates for Loans

Banks do not know the state of the SME, z , but are only aware of the transition probability of z . A SME is assumed to repay the bank loan, b , after which it will come back to the bank with a new contract, b' . However, the bank does not

know the SME's history, which means that the bank only knows b' , not b .⁵ This is the mechanism of information asymmetry. Therefore, if banks have a cumulative distribution function of belief (μ) regarding a SMEs' decision to declare bankruptcy, the expected return of b is then defined as

$$\int_b R_b(c, q_b | b) b \mu(db) - i \int_b b \mu(db),$$

in which i denotes the bank's financing cost, that is, the interest rate of consumer deposits, which is assumed to be exogenously given, and $\mu(db)$ is the probability density function with respect to b . We then define the expected return of b apart from the financing cost as follows:

$$R_b(c, q_b | b) = r(c, q_b | b) - \underbrace{f_g}_{\text{bank's contribution rate of credit guarantee fund}},$$

We assume that the loan market is perfectly competitive such that the expected profit is defined as

$$(4) \quad r(c, q_b | b) - f_g - i \equiv 0,$$

where q_b is the interest rate for b . Additionally, r is defined as

$$(5) \quad r(c, q_b | b) \equiv \underbrace{\int_z q_b \mu(d=0, dz | b)}_{\text{expected profit of non-default}} + \underbrace{\int_z \left[\frac{\pi(b, z) 1_{\{z>0\}}}{b} + c \right] \mu(d=1, dz | b)}_{\text{expected profit of default}},$$

in which $\mu(d=0, dz | b)$ and $\mu(d=1, dz | b)$ are the conditional beliefs in non-default or default with respect to z given b , and q_b is expressed with (4) and (5) in the following form:

$$(6) \quad q_b = \frac{i - \left[\int_z \left[\frac{\pi(b, z) 1_{\{z>0\}}}{b} + c \right] \mu(d=1, dz | b) - f_g \right]}{\mu(d=0 | b)} > i + f_g.$$

The determination of equation (6) is due to information asymmetry, i.e., how much the banks believe that the loan (b) which pays interest (q_b) will default. Particularly, if banks believe that $\mu(d=1 | b) = 0$, $q_b = i + f_g$ is obvious.

⁵The bank actually can review the history of SME loan cases. Our assumption can then be stronger than reality but can also be interpreted to be a gadget creating information asymmetry that can be update d in the model.

2. Government's Balanced Budget

In this paper, the government supports SMEs' financing operations through a public credit guarantee fund and an interest support program, and the government finances this from SMEs' guarantee fees, banks' contributions, and consumer taxes. Thus, the government's budget constraint is defined as

$$\int_b \left[f_g - \underbrace{\left[r_g + (1 - rc)c\mu(d=1|b) \right]}_{\text{government expenditure}} \right] b\mu(b) \geq (-f_c c - \tau) \int_{b'} b'\mu(b'),$$

in which τ is the tax rate. If the government balances its budget, the tax rate is then solved, as follows:

$$\left[r_g + (1 - rc)c \frac{\int_b b\mu(d=1, b)}{\int_{b'} b'\mu(b')} \right] - (f_g + f_c c) = \tau.$$

It is important to note that τ increases with the interest-support spread and the ratio of default loans to all loans. The ratio of default loans to all loans is determined endogenously by the proposed decision model for firms. The guarantee coverage ratio simultaneously affects government expenditures for SME policies and government revenue, but it impacts tax rates differently according to the ratio of default loans to all loans. In addition, τ decreases with the recovery rate of default loans, the bank contribution rate, and the credit-guarantee fee rate. However, the bank contribution rate can negatively influence the total credit size in the economy, and the credit-guarantee fee rate can affect the operating cash flow of SMEs such that corporate decisions may be distorted. Moreover, the recovery rate can affect the value of a bankrupted company.

3. Consumer Utility Problem

This paper assumes one representative consumer in the economy, with the following utility problem:

$$v(D, B) = \max_C U(C) + \beta E[v(D', B')].$$

She has a budget constraint for consumption (C) which is defined as

$$C = D + iB - (1 + \tau)B',$$

in which D , B , and B' , are the dividend, deposit at the previous time, and new deposit for the next period, respectively, in the aggregation such that

$$D \equiv \int_{z,b} \left[C_0 1_{\{d=0\}} + C_1 1_{\{d=1\}} \right] \mu(dz, db),$$

$$B \equiv \int_b b \mu(db), \text{ and } B' \equiv \int_{b'} b' \mu(db').$$

In particular, B and B' should be equal according to the market clearing condition.

4. Bayesian Equilibrium

The Bayesian equilibrium is defined under information asymmetry as in Athreya, Tam, and Young (2012). Athreya, Tam, and Young (2012) simultaneously analyze equilibrium without information asymmetry, but our study focuses on the optimal levels of financial support in equilibrium with imperfect information.

Definition (Bayesian Equilibrium)

The Bayesian equilibrium in the SME loan market consists of (a) a SME's loan $b^*: S \rightarrow R$ and default decision $d^*: S \rightarrow 0,1$, (b) a bank's loan interest rate $q^*: R \times M \rightarrow [1/\beta, \bar{q}] \equiv Q$, (c) the government's budget $\tau^*: R \times Q \rightarrow [0,1]$, and (d) given μ^* , the bank's belief about the SME's loan and bankrupt decision satisfies the following:

- ① SME solves the optimization problem of b^* and d^* given q_b^* .
- ② Banks offer q_b^* as a mixed Nash equilibrium under the price competition given the SME's b^* and their belief about default, $\mu^*(b)$.
- ③ The government balances the budget by adjusting τ^* given b^* , b^* , q^* , and μ^* .
- ④ A consumer chooses C^* and B^* given b^* , q^* , μ^* and τ^* .

D. Assessment of the Equilibrium Model

In this chapter, we define the SME dynamic model, bank interest rate decisions, the government's balanced budget constraint, and the abovementioned consumer's utility problem. However, discussion about the compatibility of the model is critical for the interpretation of the policy evaluation. For this reason, we assess the equilibrium model and limit the analysis of the effects of SME financial policies through a simulation.

SMEs' optimal decisions are the most important element in the model. In particular, SMEs in the model are assumed to use only loans rather than the capital markets. This is reasonable because the majority of SMEs as unlisted companies

use indirect financing according to available data. However, while analyzing the substitutability of direct financing and indirect financing via the financial markets, it becomes necessary to expand our model to the capital markets. Second, in this model, we do not take into account the industrial characteristics of SMEs. Our model basically assumes that SMEs are only manufacturing companies.

Third, the model assumes a perfectly competitive market for loans, which is not unrealistic. The paper seeks to analyze the interactions between SMEs' dynamic decisions and bank interest rates such that perfect competition is not decisive with regard to theoretical results. The fourth important feature of our model is that macro-prudential measures such as the capital ratio to risk assets are not regulated explicitly because reductions of credit amounts by banks are endogenously adjusted through changes in the loan interest rates.

Fifth, one representative consumer is assumed to own all of the SMEs. However, the SMEs' optimal decisions are determined individually. In other words, the final consumer exists only for the social welfare analysis with the economic variables of the SMEs, the banks, and the government. Finally, a price structure for the products made by the SMEs is not present because the purpose of our study is to analyze steady states of firm distributions according to market entry and exit rates rather than dynamic transitions of product prices induced by unexpected shocks.

IV. Policy Simulation in the Equilibrium Model

A. Simulation Methodology

1. Computational Methodology

The heterogeneous agent model in a state of Bayesian equilibrium can be computed by dynamic programming. Specifically, the discrete decision model regarding the bankruptcy decision can be processed by the methodology in Adda

TABLE 4—SIMULATION PARAMETERS AND RESULTS

	Parameters	Values
α	Income share of capital	0.33
β	Annual time discount rate	0.98
γ	Adjustment cost	4.0-5.5
δ	Liquidation of bankrupt SMEs	70%
$1/\lambda$	Average duration of default history record	2
c	Average guarantee coverage ratio	90%
i	Average gross deposit rate	4.1%
f_c	Average credit guarantee fee rate	1.1%
f_g	Bank's contribution rate to credit guarantee fund	0.38%
rc	Average recovery rate from indemnity	20%
Leverage ratio	Base model ($r_g \in [0.000, 0.045]$)	141%~308%
Leverage ratio	KIS DB from FY 2000 to FY 2011	293%~356%
Subrogation rate	Base model ($r_g \in [0.000, 0.045]$)	4.68%~10.6%
Subrogation rate	KODIT from FY 2007 to FY 2013	4.1%~5.0%

and Cooper (2003).⁶

2. Simulation Parameters

Before simulating the model, the outside parameters should be determined given the economic context. Table 4 shows the values of the outside parameters. First, we use the value from Park (2012), 0.33, as the capital income-share parameter. The annual time discount rate is set to 0.98 considering the interest spread and deposit rate, and the parameter of adjustment cost function used ranges from 4.0 to 5.5 such that we have a range of simulation results. The business liquidation rate of bankrupt SMEs is 70%, close to the value in Kang (2004), and the average coverage ratio is assumed to be 90%. The average deposit rate is the average interest rate for new deposits from 2001 to 2013 at BOK ECOS, 4.1%. The average credit guarantee fee rate and recovery rate of indemnity are respectively 1.1% and 20% from Kang (2005). The bank contribution rate to credit guarantee funding takes its value from Kang et al. (2014), i.e., 0.38%. The interest-support spread ranges from 0.00% to 4.5% at increments of 50bp. We then calculate the average leverage ratios and average subrogation rates.

In Table 4, the leverage ratio of manufacturing SMEs from FY 2000 to FY 2011 in the KIS database ranges from 293% to 356%. From the simulation, we compute the leverage ratio of SMEs as ranging from 141% to 308%. In addition, the KODIT subrogation rate from FY 2007 to FY 2013 has a range of 4.1% to 5.0%, and the range of the simulation is from 4.68% to 10.6% according to the range of the interest-support spread.

B. Equilibrium Simulation Results

1. Consumer Social Welfare in Equilibrium

Figure 2 shows the final tax rate of the consumer according to the coverage ratio and interest-support spread under a state of equilibrium. Without the credit guarantee and interest support programs, the consumer will have the lowest tax rate, SMEs will not pay the guarantee fee, and banks will not contribute to public guarantee funds. In addition, the tax rate does not increase monotonically, as it shows an \cap -shaped decline at a coverage ratio of 60%. The growth of bankruptcies by SMEs responds non-monotonically to policy variables and the expected return curves of banks.

Figure 3 shows the final consumption at equilibrium according to the coverage ratio and the interest-support spread. Surprisingly, consumption is relatively high at lower coverage ratios and interest-support spreads. This phenomenon has two causes. First, the higher guarantee coverage ratio and interest-support spread imply

⁶Find steps of computation in the appendix.

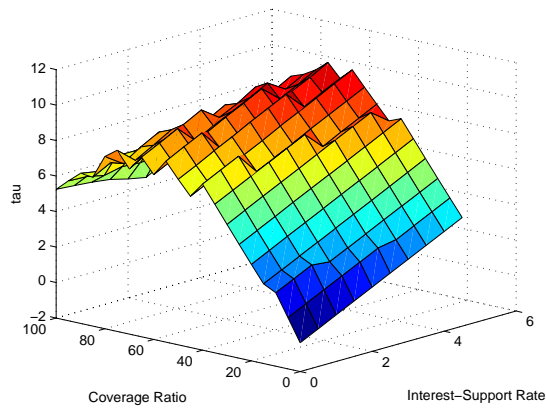


FIGURE 2. CONSUMER’S TAX RATE AT EQUILIBRIUM (UNIT: %)

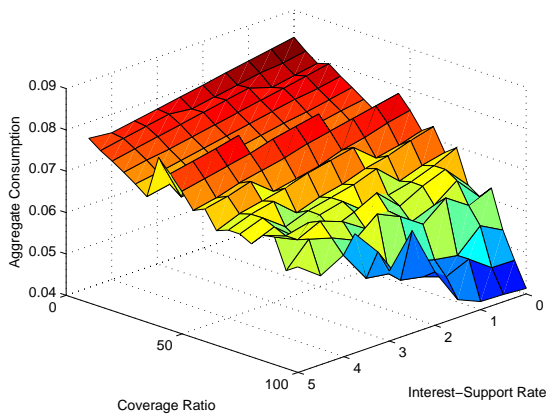


FIGURE 3. CONSUMPTION AT EQUILIBRIUM (UNIT: %)

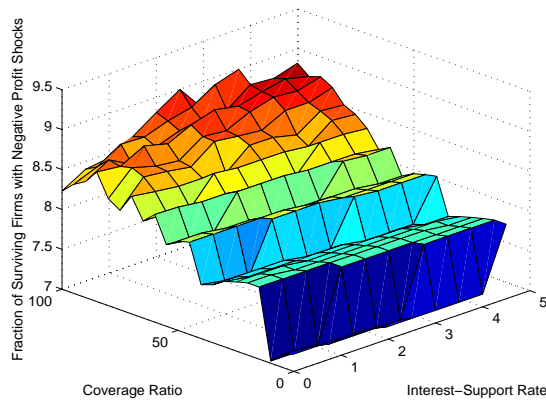


FIGURE 4. PROPORTIONS OF MARGINAL SMEs IN THE MARKET AT EQUILIBRIUM (UNIT: %)

that the consumer pays more tax, causing the social cost to increase. Second, marginal SMEs' exits are delayed due to the credit guarantee and interest support programs, after which the overall profitability of the economy declines as the proportion of marginal companies in the market increases. In Figure 4, although the proportion of operating SMEs with negative profits is close to 7% at equilibrium without the credit guarantee and interest support programs, the proportion at equilibrium with these programs increases to 9%. Finally, the figure shows that the financial policies for SMEs are likely to delay marginal SMEs' exits and thus lower the final consumption rate. Thus, the cost of the risk sharing of SMEs' bankruptcy and the reduced consumption level can lower social welfare overall.

2. Optimal Levels of Financial Support and Social Welfare

Table 5 shows the optimal levels of the coverage ratio and interest-support spread according to the recovery rates of indemnity as determined via a simulation.⁷ The optimal levels of the coverage ratio at recovery rates of 20% and 40% are 8.75% and 16.25%, respectively. It should also be noted that the optimal coverage ratio is in fact the proportion of the credit guarantee size out of the overall SME loan amounts. The optimal rates of the interest-support spread at recovery rates of 20% and 40% are 25bp and 50bp, respectively. Finally, an increase in the recovery rate of indemnity can alleviate the government's budget line such that it can then expand credit guarantees and interest-support spreads due to the reduced social cost.

Our equilibrium model takes into account the decision-making activities of several economic agents. The coverage ratio of credit guarantees directly influences the decisions of firms, banks, and the government, and the interest-support program directly impacts corporate and governmental decisions, whereas it indirectly affects banks' decisions. However, a clear analysis of the effects of SME financial policies on the real economy is not easy to conduct. The present paper can only foretell the impacts of financial policies by computing social welfare through the distribution of leverage and the default probability via the behavior of economic agents.

In this context, the recovery rate of indemnity critically affects the economy. The recovery rate influences the value of bankrupt companies such that a higher recovery rate increases the debt burdens of firms. Simultaneously, a higher recovery rate of indemnity positively affects social welfare because the social cost decreases. Table 6 shows the effect of the increase of the recovery rate on consumption, the tax rate, and the default rate. If the recovery rate increases by 5%p from the base model, consumption increases by 0.95% and the tax rate and the default rate decrease by 5.29% and 0.38%, respectively. In addition, when consumption increases by 3.50%p, the tax rate and the default rate decrease by 22.7% and 1.66%, respectively, according to an increase in the recovery rate of 100%.

⁷The counterfactual assumptions of recovery rates are 25% and 40%. The rate of 25% is based on the recovery rate of commercial banks, and 40% represents an increase in the recovery rate of the baseline by 100%.

TABLE 5—OPTIMAL COVERAGE RATIO AND
INTEREST-SUPPORT SPREAD ACCORDING TO THE RECOVERY RATE

Recovery rate (rc)	Coverage ratio (c)	Interest-support spread (r_g)
20%	8.75%	0.25%
25%	8.75%	0.25%
40%	16.25%	0.50%

Note: This table shows average values of results according to γ ranging from 4.0 to 5.5.

TABLE 6—CHANGES IN SOCIAL WELFARE ACCORDING TO
AN INCREASE IN THE RECOVERY RATE

From 20% (rc)	Consumption (C)	Tax (τ)	Default rate
5%p increase	+0.95%	-5.29%	-0.38%
20%p increase	+3.50%	-22.7%	-1.66%

Note: This table shows average values of results according to γ ranging from 4.0 to 5.5.

V. Analysis of the Continuous Treatment Effect for Credit Guarantees

In this section, we analyze the effects of a credit guarantee program on performance when SMEs are supported by KODIT. In particular, we use the ratio of guaranteed debt to the total debt in a continuous treatment rather than a binary treatment effect analysis of the average treatment effect (Hirano and Imbens 2004). This analysis of the continuous treatment effect can determine the marginal effect of policy variables instead of the average effect of exposure to a policy. Moreover, most Korean policy-research papers analyze only the average treatment effect; hence, the present analysis of the continuous treatment effect contributes to the research on SME financial policies in an important way.

A. Methodology of the Analysis of the Continuous Treatment Effect

1. Generalized Propensity Score Method

Our analysis is based on the GPS (generalized propensity score) method of Hirano and Imbens (2004). The generalized propensity score removes the endogeneity of selection bias by controlling the propensity to be selected through the characteristics of objects as the generalization of the propensity score for a binary treatment effect. Hirano and Imbens (2004) assume unconfoundedness when controlling this endogeneity such that for any treatment $t \in [0, 1]$, $Y(t) \perp T | X$, is satisfied. $Y(t)$ denotes the performance of the treatment variable (t), T represents the continuous treatment, X is the pre-treatment variable in each case, properly defined based on the probability measure. This assumption means that the treatment characteristics are independent of the performance. Another assumption is a balancing property such that

$$X \perp 1\{T=t\} \mid \rho(t, x),$$

in which $\rho(t, x)$ is $f_{T|X}(t|x)$, the conditional probability of the treatment derived characteristics.

Hirano and Imbens (2004) prove using these assumptions that

$$f_T(t \mid \rho(t, X), Y(t)) = f_T(t \mid \rho(t, X)) \text{ and} \\ \Xi(t, r) = E[Y(t) \mid \rho(t, X) = \rho] = E[Y \mid T = t, R = \rho].$$

The last equation is $\psi(t) = E[\Xi(t, \rho(t, X))]$, representing the expected performance according to continuous treatment and the generalized propensity score.

In more detail, regarding the given characteristics X_i , we assume that $g(T_i) \mid X_i \sim N\{h(\xi, X_i), \sigma^2\}$. Subsequently, from

$$\hat{R}_i = \frac{1}{\sqrt{2\pi\hat{\sigma}^2}} \exp\left[-\frac{1}{2\hat{\sigma}^2} \left\{g(T_i) - h(\hat{\xi}, X_i)\right\}^2\right],$$

we can estimate the GPS by means of maximum likelihood estimation.

Next, we estimate the expected performance using quadratic regression with estimated GPS and continuous treatment variable such that

$$E(Y_i \mid T_i, R_i) = \psi(T_i, R_i; \alpha) = \alpha_0 + \alpha_1 T_i + \alpha_2 T_i^2 + \alpha_3 R_i + \alpha_4 R_i^2 + \alpha_5 T_i R_i.$$

Finally, we calculate the average performance according to each treatment level with the expected performance such that

$$E\{\hat{Y}(t)\} = \frac{1}{N} \sum_{i=1}^N \hat{\psi}\{T_i, \hat{R}_i; \hat{\alpha}\}.$$

2. Data for the Empirical Analysis

The data used here are the loan guarantees of KODIT from FY 2008 to FY 2011. We merged the KODIT data and the KIS database for the SME performance measures. The average coverage ratio for a loan is 92.9%, and most loan guarantees have coverage ratios of 85%, 90%, 95%, and 100%. It should also be noted that most coverage ratios are high and inflexible considering the SMEs' characteristics.

We compute the ratio of guaranteed debt to total debt for each SME in the KODIT data as the continuous treatment effect. If the maturity of the guarantee is longer than one year, we cover that loan for longer than one year, and if one SME

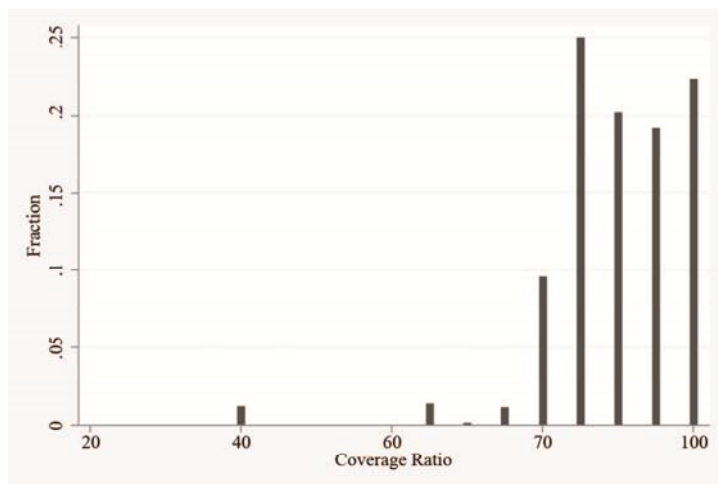


FIGURE 5. DISTRIBUTION OF COVERAGE RATIOS FOR SME LOANS

Data: Loan cases of KODIT from FY 2008 to FY 2011.

has several credit guarantees for loans, we compute the ratio of guaranteed debt to total debt by adjusting the data according to the maturities of the guarantees.

The log values of total assets, debt to assets, ROA, trade payables to sales, and the financial cost to the total cost are used as the SMEs' pre-treatment variables (or characteristics), from Nam (2013b). Additionally, the interest expense with regard to the total debt and the log values of sales are used to control the interest cost according to the change in the credit amount and the operating performance values, respectively.

When dealing with raw data, we need to adjust the time lag between the pre-treatment variables (firm characteristics) and the performance measures. First, every variable is computed as of the end of the fiscal year. If a credit guarantee was approved before the end of June in year t , then both the pre-treatment variables at year $t-1$ and the performance measures at year t are considered in the same observation. If the time of approval of the credit guarantee was after the end of June in year t , then the pre-treatment variables at year t , and performance measures at year $t+1$ are considered in the same observation. Thus, guaranteed debt which started in March of 2008 is grouped with the pre-treatment variables of 2007, but not with the pre-treatment variables of 2008, implying that KODIT's decisions on credit guarantees made before July are assumed to include only the information up to the previous year, whereas decisions after June are assumed partially to use the information of the same year. In addition, if one firm has several guarantees during the same year, we compute the observation as of the latest time because the first decision among the guarantees is assumed to have used the most crucial information.

B. Results of the Continuous Treatment Analysis

1. Basic Statistics

The number of firm-year observations computed through the method explained in the previous section is 38,370, but most SMEs in the data are not externally audited. Therefore, the data are less reliable given this information and the great number of outliers. Thus, we randomly sample 3,000 observations.⁸

Table 7 shows the statistics of the randomly sampled data used here. The mean, median, and standard deviation of the continuous treated guaranteed debt over the total debt are 39.3%, 28.3%, 32.5%, respectively. However, the proportion of examples with a 100% guarantee for all debt amounts to 12%, indicating that all of the debt of some SMEs is completely covered by credit guarantees. Thus, these SMEs may be considered to have excessive financial support from the government.

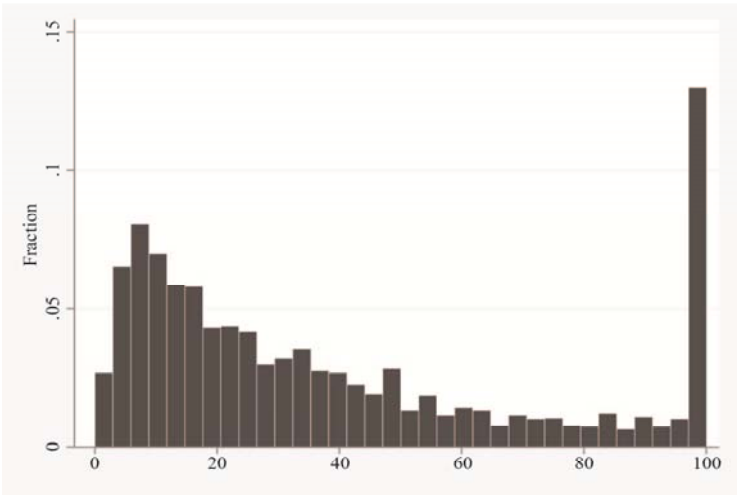


FIGURE 6. DISTRIBUTION OF THE RATIO OF GUARANTEED DEBT TO TOTAL DEBT

Data: KODIT’s loan data (FY 2008~FY 2011), KIS Database.

TABLE 7— BASIC STATISTICS OF PRE-TREATMENTS AND PERFORMANCES

Variables	Mean	Median	S.D.
Guaranteed debt/total debt	39.3%	28.3%	32.5%
Log (assets)	14.3	14.4	1.39
Log (sales)	15.0	15.0	1.36
Total debt/assets	34.8%	35.8%	26.1%
ROA	6.62%	9.96%	80.4%
Trade payables/sales	4.09%	6.57%	9.04%
Financial cost/total cost	0.98%	1.91%	3.62%
Interest cost/total debt	5.96%	7.04%	7.58%

Data: KODIT’s loan data (FY 2008~FY 2011), KIS database.

⁸As a pre-analysis, the main features of the empirical results with all observations are consistent with those of the randomly sampled observations.

TABLE 8—COEFFICIENTS OF GPS FOR GUARANTEED DEBT TO TOTAL DEBT

Variables	Coefficients	t-values
Log (sales)	0.03	1.04
Log (assets)	-0.41	-12.9
Total debt/assets	-0.02	-15.8
ROA	-0.01	-5.67
Trade payables/sales	0.000	0.01
Financial cost/total cost	0.001	0.15
Interest cost/total debt	0.002	0.89

According to Table 8, the log (assets), total debt/assets, and ROA significantly influence the GPS function.

2. Analysis Results

Table 8 shows the GPS coefficients for the continuous treatment log-normalized, ratio of guaranteed debt to total debt using the method of Hirano and Imbens (2004). The log values of sales, the total debt to assets, and the ROA are negatively and significantly correlated with the continuous treatment, indicating that as a firm is smaller, has less debt, and is less profitable, it can have relatively more guarantees.

Table 9 shows the statistics of firms' financial ratios as continuous treatment performance measures. Recently, the means of the growth rates of net income and capital have been negative due to poor operating conditions and low profitability, but the medians stand at 14.9% and 19.4%, respectively. Although most studies commonly use the growth rate of assets or sales as performance measures, these variables are not completely free from endogeneity because the growth of assets must be correlated with an increase in debt by credit guarantees and the approval of a credit guarantee may be due to a new contract promising massive sales. Therefore, we only use the value-added to capital and the value-added to sales as performance measures of SME productivity and use the growth rates of net income and capital to represent profitability and growth potential.

Figures 7-10 show the continuous treatment effects and the percentage ratio of guaranteed debt to all debt on firms' performances. Specifically, the upper panel in the figure shows the marginal effect of a 1%p increment in treatment, and the lower panel shows the level effect of the treatment.

Figure 7 shows the effect of the treatment on the percentage ratio of value-added to capital. The upper panel shows that the marginal effect of the policy treatment is highest from 15% to 20%, and the marginal effect decreases with doses of the

TABLE 9—BASIC STATISTICS OF PERFORMANCE MEASURES

Variables	Mean	Median	S.D.
Value-added/capital	68.6%	43.9%	85.7%
Value-added/sales	28.1%	24.3%	25.6%
Growth of net income	-36.2%	14.9%	3,566%
Growth of capital	-8.53%	19.4%	3,994%

Data: KIS Database.

treatment such that the response function peaks at a guaranteed debt to total debt ratio of 65%.

Figure 8 shows that the marginal effect of the treatment on value-added to assets is highest at around 15% and that the performance of the treatment peaks at 65%. Figure 13 shows the similarity of the effect of net income growth with the results presented in Figure 12. Particularly, the marginal effect of this treatment becomes more significance as the treatment increases.

Figure 9 shows a similar pattern in that the marginal effect is higher at lower treatment values, and the response has its greatest effect in the middle of the treatment. Figure 10 shows the effect of the treatment on capital growth. The marginal effect decreases with the treatment and negatively affects capital growth when the ratio of guaranteed debt to all debt exceeds 65%.

According to the empirical results, the public guarantee program has a positive impact on a firm's performance when the firm's total debt is less covered by such a guarantee program. However, as coverage by the guarantee program for a firm's

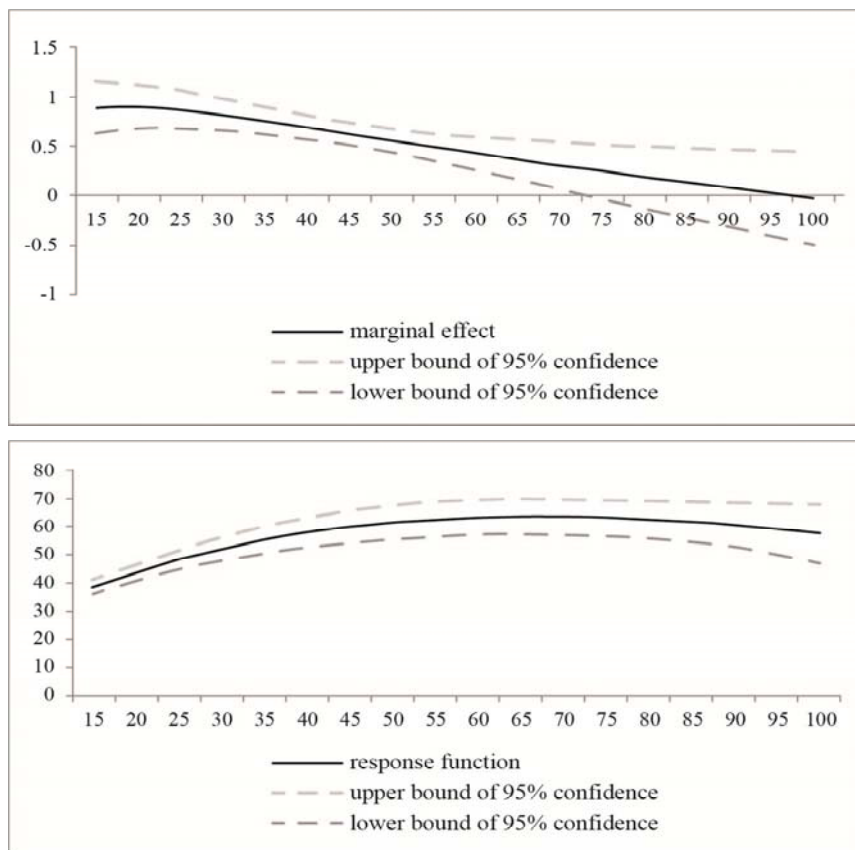


FIGURE 7—DOSE FUNCTION AND RESPONSE FUNCTION FOR
VALUE-ADDED TO CAPITAL

Note: The horizon axis denotes guaranteed debt to total debt (%), and the vertical axis is performance measure (%). The upper panel shows the dose effect for a 1%p increment of the treatment, and the lower panel shows the response of the performance measure to the treatment.

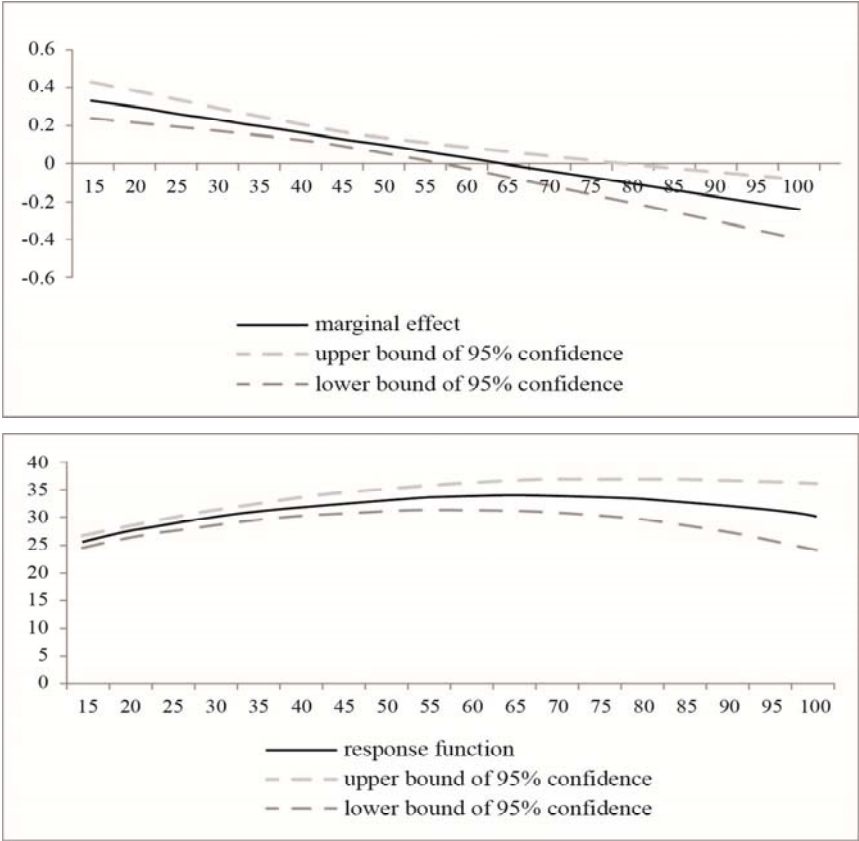


FIGURE 8. DOSE FUNCTION AND RESPONSE FUNCTION FOR
VALUE-ADDED TO SALES

Note: The horizon axis denotes guaranteed debt to total debt (%), and the vertical axis is performance measure (%). The upper panel shows the dose effect for a 1%p increment of the treatment, and the lower panel shows the response of the performance measure to the treatment.

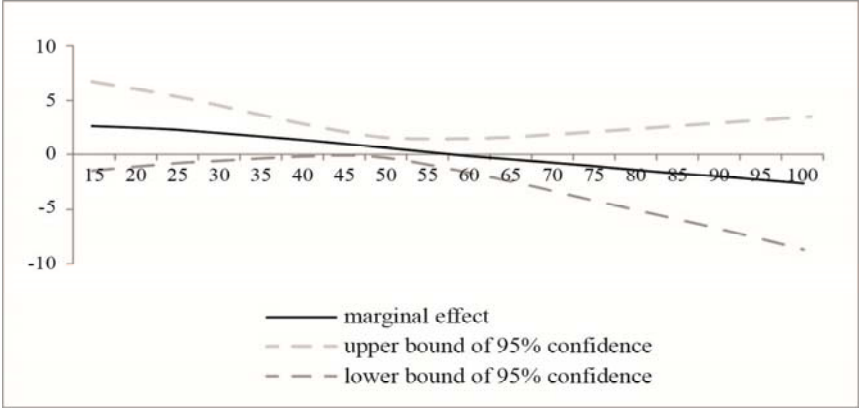


FIGURE 9. DOSE FUNCTION AND RESPONSE FUNCTION FOR
NET INCOME GROWTH

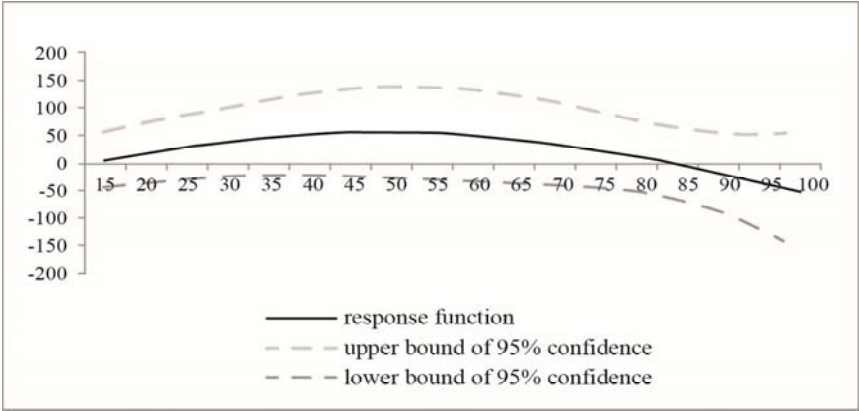


FIGURE 9. DOSE FUNCTION AND RESPONSE FUNCTION FOR NET INCOME GROWTH (CONTINUED)

Note: The horizon axis represents the guaranteed debt to total debt (%), and the vertical axis is the performance measure (%). The upper panel shows the dose effect for a 1%p increment of the treatment, and the lower panel shows the response of the performance measure to the treatment.

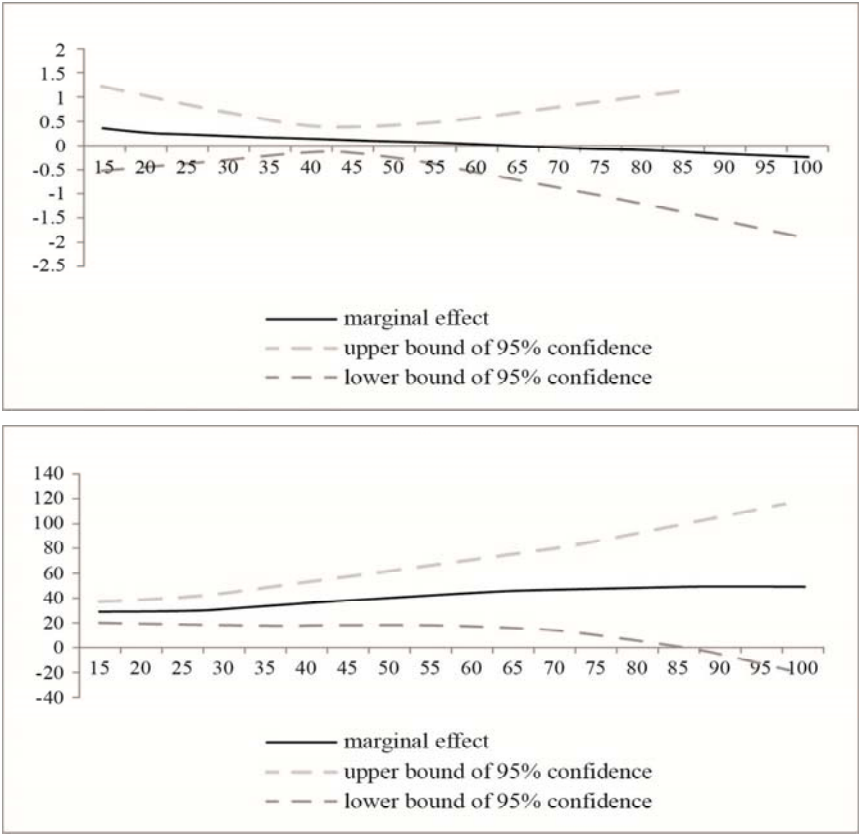


FIGURE 10. DOSE FUNCTION AND RESPONSE FUNCTION FOR CAPITAL GROWTH

Note: The horizon axis denotes the guaranteed debt to total debt (%), and the vertical axis is the performance measure (%). The upper panel shows the dose effect for a 1%p increment of the treatment, and the lower panel shows the response of the performance measure to the treatment.

total debt increases, the firm faces a moral hazard because the burden of all debt can be avoided by the credit guarantee. Therefore, the excessive supply of public guarantees for SMEs while not considering the efficient allocation of public resources may negatively influence economic performance overall given the prevalence of moral hazard on the part of the borrower.

VI. Conclusion

This paper investigates how financial support schemes such as credit guarantee and interest support programs for SMEs dynamically affect corporate decisions, including default decisions, in an equilibrium model with information asymmetry. Particularly, we calculate the optimal sizes of the credit guarantee and interest-support spread in a perfectly competitive loan market with imperfect information for SMEs. The simulation results show that the current levels of the credit guarantee size and interest-support spread may be excessive, thus above the optimal levels.

Second, our study empirically analyzes the effects of credit guarantee programs using the ratio of guaranteed debt to total debt as a continuous treatment variable with the GPS method. According to the results, the marginal effects of credit guarantees of productivity, profitability and growth potential decrease with the ratio of guaranteed loans to total debt. In addition, the response functions for a credit guarantee peaks between 50% and 60%.

Finally, this paper proposes several policy improvements for the credit guarantee programs. First, the government needs to lower the amount of total credit guarantees with reference to all SME loans because the proportion of the public credit guarantee to all SME loans at Korea is higher than those in other OECD countries, and theoretical simulations show that consumers pay more tax than the optimal level of social welfare. Moreover, it is possible that the excessive financial support for SMEs hampers prudential firm dynamics, including productivity and investment, by delaying the exit of poor SMEs from the market.

Second, an increase in the SME guarantee fee or bank contribution rate is more likely to boost the default rate or loan interest rate such that any positive effects of the SME financial support may be weakened. Thus, the government needs to strengthen regulations pertaining to recovery for indemnity from bankrupt companies, which would distort the default rate and loan interest rate less. Despite the limitations of our model, it was found that an increase in the recovery rate of 100% can reduce the consumer tax burden by 22.7%. Additionally, strong policies for collecting debt from bankrupt SMEs can prevent moral hazard.

Lastly, current regulations which control the amount of credit guarantees per firm do not limit the proportion of credit guarantees to a firm's total debt. Therefore, the government must regulate the limit on the ratio of guaranteed debt to overall debt and must flexibly manage the coverage ratio for each loan application in order to prevent the negative effects of the credit guarantee program.

APPENDIX

1. *Computation of transition probability of z*

In order to compute z , we define the return on assets such that

$$ROA = z(1+b)^{\alpha-1},$$

and if the leverage is defined as b , then

$$\frac{ROA}{(1+b)^{\alpha-1}} = z$$

can be computed. First, we compute z with data from FY 2000 to FY 2011 from the KIS database, categorizing 25 ranges of z . Finally, the transition probability of z is computed with a matrix of z 25×25 in size. This method is analogous to the approach taken by Adda and Cooper (2003).

2. *Computation of the dynamic model*

We compute the upper limit of b , \bar{b} , such that

$$\frac{\bar{z}(1+\bar{b})^{\alpha}}{\bar{q}-1} \geq \bar{b}.$$

1. Compute $V_T(b, z)$ by the backward induction of dynamic programming given q_0 .
2. Compute $V_{T-1}(b, z)$ with $V_{0,T-1}(b, z)$ and $V_{1,T-1}(b, z)$ after computing $E[V_T(b)]$ using the transition matrix of z .
3. Repeat step 2 until $V(b, z)$ converges with some extent to precision.
4. Through steps 2 and 3, find the firm's optimal policy given (b, z) and then compute $\mu(b, z)$.
5. Compute q_1 with μ .
6. Repeat from step 1 to step 5 until q is converged with some extent to precision.
7. Compute B^* , τ^* , and C^* with μ^* and q^* in step 6.

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