Government loan guarantees and the credit decision-making structure

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Abstract. Governments can alleviate the problem of banks denying credit to high risk borrowers and excluding weaker sectors from borrowing by introducing state-guaranteed loan programs. The main contribution of this paper is the elucidation of the importance of the bank's credit decision-making structure in ensuring overall effectiveness of loan guarantees. In particular, the government can use the guarantee as an instrument for credit inducement and for affecting the bank's decision-making system i.e., its degree of centralization, bias towards approval of loans and reliance on objective loan-specific information.

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1. Introduction.

Governments intervene in the credit market in order to provide loans in cases where private markets will not. They act in response to difficulties faced by certain sectors in obtaining credit. These sectors include households who seek mortgages, small businesses, minorities, women and developing regions or industries. The reluctance of banks to grant credit is due to the high risk associated with lending to these sectors. In this study we analyze a bank's credit decision structure focusing on the effect of a government loan guarantee on credit allocation. We wish to contribute to a better understanding of the micro foundations of macro-economic phenomena in which bank lending plays a crucial role. The emphasis is on clarifying the importance of the decision-making structure for determining the success of such a government guarantee in achieving its goal of appropriate lending inducement. In fact, the government can determine the marginal credit-effectiveness of a loan guarantee, and can affect the degree of centralization of the bank's decision-making system, the bias towards approval of loans and the extent of reliance on objective information relevant to any specific loan.

A large number of countries have government-sponsored credit guarantee schemes, including the majority of OECD countries. We learn from Green (2003), that there are over 2,250 guarantee schemes in more than 100 countries. The OECD in its 2012 report[1] discusses the design of Government Credit Guarantee Schemes (CGS) and Mutual Credit Guarantee

[1]OECD Centre for Entrepreneurship, *SME and Entrepreneurship Financing: The Role of Credit Guarantee Schemes and Mutual Guarantee Societies in supporting finance for small and medium-sized enterprises*, 30-Jan-2013, CFE/SME(2012)1/FINAL.

schemes, pointing to the fact that, following the 2008 economic crisis, many existing schemes were expanded and new schemes were set up in an effort to overcome the economic crisis. The OECD report shows that the volume of credit guarantee schemes can reach 7.3% of GDP as in the case of Japan. However, there is great heterogeneity in the design of scheme mechanisms. Specifically, of interest to this study is the fact that credit assessments and credit decisions can be made by the public entity that provides the guarantee, the lending institution or both. In this sense alone there is variation in the level of centralization of the credit decision within different credit schemes. In Austria, Bulgaria, The Czech Republic, France, Germany, Hungary, Italy, Netherlands, Poland, Romania, Russia, Slovania, Spain and Turkey, only one of the above institutions makes the credit decision. Whereas in Belgium, Estonia, France, Greece, Latvia, Lithuania, Luxemburg and Portugal both institutions make the credit decision. The difference in decision-making centralization arises from variations in the types of schemes as well as legal issues, nonetheless illustrating the difference in decision design at the national level. Furthermore, each organization, the public entity and the private lender, will have their own organizational design for which data is sparsely available. However, as the OECD report states: "The design of CGSs is crucial for their effectiveness and sustainability". In this study we focus on the decision structure of the organization and its effect on the CGS.

Specific examples of government loan guarantee schemes are Germany, where government guarantees were provided for loans given by savings banks until 2001 (Gropp, Guettler and Saadi 2015). The U.S. government has in the past used different institutions for its individual loan programs whose purpose is to increase lending through banks, e.g., government sponsored secondary market mortgage institutions, such as Fannie Mae and Freddie Mac and notably, the Small Business Administration, which provides government guarantees to private financial intermediaries. In the U.K. a loan guarantee scheme provides access to credit to small firms suffering from credit rationing. Over the period 1998-2001 Japanese banks gave government loans to SMEs (Uesugi, Sakai and Yamashiro, 2010) and in 2008 the Japanese government set up the Emergency Credit Guarantee Program (Ono, Uesugi and Yasuda 2013). In both studies on Japanese Government loan schemes, the authors found that the credit programs were successful at increasing lending to the firms that participated. Cowan, Drexler and Yaoez (2015) find that the Chilean partial credit guarantee scheme increased lending to SMEs but also increased default rates due to adverse selection created by the scheme.

Loan guarantees reduce the risk faced by the lender. But they may have an undesirable effect of applying unsatisfactory loan screening methods and decision structures to loan requests.[2] Moreover, Honohan (2010) reviews and discusses the goals and costs of partial credit guarantee schemes exposing the difficulty in estimating the social benefit from such schemes, despite their popularity. In this study we define effectiveness of a guarantee scheme as the maximal increase in lending. While this is the primary goal of a credit guarantee scheme, there are additional criteria of effectiveness that concern the economy. For a credit guarantee scheme to be successful at increasing growth in the economy the increase in lending should be channeled to companies that are most likely to experience growth and further investment. Furthermore, it should be apportioned to firms that are most likely to be profitable and pay back their loans. Otherwise the scheme will become extremely costly and hence ineffective from a cost-benefit point of view.

[2] For credit scoring methods see Mester (1997), Altman and Saunders (1997) and Allen, Delong and Saunders (2004) and for literature analyzing the design of appropriate cut-off methods for credit decisions when a credit score is provided see Andersson (2004). Much less research has been devoted to the design of the decision-making structure in banks.

The objective of the present study is to examine the effect of a government's loan guarantee on lending and on the design of the bank's decision-making system i.e., its degree of centralization, bias towards approval of loans and extent of reliance on objective loan-specific information. This objective is carried out by focusing on the bank's credit decision, viz., whether to approve or reject a specific loan request. The decision is analyzed applying the uncertain dichotomous choice setting that stresses the role of the decision-making structure, namely, the decision rule that aggregates the committee members' credit decisions. The question of how a bank's organizational structure affects its credit decisions has been discussed within the context of credit availability for SMEs. Notably, Berger and Udell (2002) argue that different types of lending (relationship lending vs. transactional lending) require different organizational structures for banks. More specifically, since small borrowers typically generate soft information, they will succeed more at obtaining credit from less hierarchical banks were loan officers can make credit decisions on their own. Stein (2002) discusses the effect of two specific (centralized vs. decentralized) such designs on the share of small business lending. Canales and Nanda (2012) studies the organizational structure that provides better lending terms for small businesses, finding that decentralized banks provide larger loans to small businesses. These findings are further supported by Cotugno, Mnoferrà and Sampagnaro (2013) where hierarchical distance is shown to be negatively related to credit availability. However, the decision structure not only affects the likelihood of loan approval, but also determines the quality of the loan decision. Liberti and Mian (2009) find that greater hierarchical distance between the agent who collects information and the loan officer who makes the loan decision leads to less reliance on subjective information and more reliance on objective information. Meissner (2005) studies the effect of the number of votes needed to approve loans using historical data from New England focusing on the approval of loans with private gains and emphasizing the effect on good lending practices. Graham, Harvey and Puri (2015) examine the decision process and use of information as it is reflected in the delegation of financial decisions within firms. In the following we set out to address the question of how the organizational structure of banks determines the effectiveness of credit guarantee schemes.

Our theoretical framework is that of group decision-making in a committee of fixed size that is subject to human fallibility. This field of study has attracted a great deal of attention. Nitzan and Paroush (1982, 1985), Grofman, Owenand and Feld (1983) and Shapely and Grofman (1984) laid the theoretical foundations of the uncertain binary choice model.[3] Following previous results, Ben-Yashar and Nitzan (1997) defined the optimal decision rule in an extended setting which allows asymmetric choice. The loan guarantee framework allows us to demonstrate how these results can be applied to resolving a specific issue faced by the government, leading to new insights into the decision rule. In our banking application of this model, a credit committee is appointed by the bank's board of directors. In the bank setting this committee can be interpreted as a group of decision makers who meet in order to vote on loan approval, a structure of management, central offices and branches all of whom are part of a chain of decision makers on loan approval, or a credit scoring model.[4] The task of the committee is to approve or reject a loan request while trying to reach the correct

[3] Sah (1991) and Sah and Stiglitz (1986, 1988) applied the asymmetric model to study the architecture of economic systems and, in particular to compare the performance of hierarchies and polyarchies. Other studies analyzed the optimal decision rule under constraints, e.g., Ben-Yashar, Kraus and Khuller (2001) and Ben-Yashar and Kraus (2002), the optimal decision rule in polychotomous choice, Ben-Yashar and Paroush (2001), and the optimal allocation of committee members, Ben-Yashar and Danziger (2011). Since the seminal work of Austen-Smith and Banks (1996), much attention has been also devoted to the role of strategic decisions, see for example, Ben-Yashar and Milchtaich (2007). Also see Dietrich and List (2013).

[4] Banks are also known to widely use credit scoring models, in which case a credit committee member can be interpreted as a criterion in the credit scoring model.

decision concerning loan approval. Each committee member has expertise in determining whether or not a loan should be granted. The decisions of the credit committee members are aggregated by using a decision rule that yields a final decision regarding the approval or rejection of the requested loan. In our setting the government can use a loan guarantee as an effective tool to increase lending. Our first main theorem shows that the structure of decision making in the bank determines the effectiveness of a loan guarantee in increasing lending to high-risk borrowers. More specifically, for a given guarantee level, it is shown that the government can expect the maximal increase in lending by varying the guarantee when the simple majority rule is used to aggregate the decisions of the committee members and the minimal increase when the committee applies a centralized or a decentralized decision rule. This implies that if the government can control both the loan guarantee and the decision-making rule applied by the bank or, alternatively, it can set only the guarantee, but is aware of the reaction function of the bank to the guarantee, the government can exploit its advantage and set the guarantee that induces the maximal lending or the maximal marginal effect of the guarantee on lending that implies maximal reliance on objective loan-specific information. Our second theorem illustrates this possibility for the particular environment where the risk of the projects faced by borrowers is distributed uniformly.

Our findings stress the importance of the decision-making structure of the financial institution used by the government for its guarantee program and specifically provide a theoretic basis for the reduced effectiveness of such programs in organizations with centralized decision structures. These theoretic findings concur with the empirical literature on government guarantee schemes that have been widely used to increase lending to small and medium sized enterprises. A detailed analysis of the organization and success of such schemes can be found in Green (2003). These schemes are found to be efficient in increasing lending especially in emerging and industrialized countries. According to Green (2003) one explanation can be found in the design and implementation of guarantee schemes. Specifically the degree of centralization of the lending organization is a factor that determines efficiency. Green (2003) finds that in developing countries, which tend to be over centralized in the sense that a central office makes the final decision on loan approval, the schemes are less effective. In particular, our findings emphasize that a loan guarantee affects not only the final credit decision, but also the bank's decision-making structure.

2. The model.

An entrepreneur who has no wealth can apply to the bank for a loan of 1 unit, which if granted, allows him to proceed with a project that requires 1 unit of investment. The loan can be used only for the purpose of investing in the project. A project returns either *Y*, which is fully observable, with probability $P_y > 0$ or zero with probability $(1 - P_y)$. The entrepreneur knows the characteristics of his project, so from his point of view, the expected return from his proposed project is $P_y Y$. The probability P_y represents the project's risk level whereby a low risk project is associated with a high P_y. The bank's success depends on the realization of the return *Y* on the project, that is, on the probability P_y. However, a project's P_y is unknown to the bank. For the bank it is a random variable that varies according to a commonly known distribution function.

The bank must decide whether to approve or reject the entrepreneur's loan application, taking into account that the gross cost of lending 1 unit is equal to $C \geq 1$. Setting the risk-free rate to zero, loan repayment is $R>1$ ensuring that both the bank and the entrepreneur are able

to participate in the program such that $Y>R>C$[5]. Government intervention is represented by a guarantee, g[6]. The guarantee g is the amount by which the bank is reimbursed by the government in the event that the entrepreneur cannot repay the loan and it is set such that, $0 \leq g \leq R$ .There are two types of loans, good loans (1) and bad loans (-1). A correct decision is to approve (1) a good loan and to reject (-1) a bad loan. A good loan is a loan that finances a project with a probability of success $P_y > \tau$, where τ is the threshold probability of success that determines what is a correct decision from the bank's standpoint, i.e., the bank has a positive expected income from a loan. The threshold probability τ is determined by the parameters known to the bank, g, C, and R, such that for cases where $P_y > \tau$, $\tau = \frac{C-g}{R-g}$, a loan provides the bank with expected income, $P_y R + (1-P_y)g - C > 0$. Hence, given the distribution function $f(P_y)$ of P_y , the a-priori probability of a good loan, α , is determined as follows: $\alpha = \int_{\tau}^{1} f(P_y) dP_y$. Since $\frac{\partial \tau}{\partial g} < 0$[7], it follows that $\frac{\partial \alpha}{\partial g} > 0$. That is, an increase in the size of the guarantee lowers the threshold for good loans resulting in a larger a-priori probability that the bank faces a good loan.

Since the probability P_y is unknown to the bank, the bank's board of directors appoints a credit committee of $n=2k+1$ members whose task is to approve or reject a loan application by assessing whether $P_y > \tau$ or not. The common objective of all the credit committee members is to make the correct decision concerning loan approval.[8] Each member's decision regarding the type of loan (good or bad) is based on his specific information, such as past experience in lending to the entrepreneur, the entrepreneur's leverage and other attributes of the entrepreneur and of the loan application. A credit committee member's decisional skill is represented by p, $1/2< p<1$, which represents his probability of approving a good loan and rejecting a bad one. We assume that the committee members have homogeneous skills and that decisional skills are statistically independent across credit committee members. A final decision is reached by applying a decisive decision rule, which is a function that assigns 1 (approval) or -1 (rejection) to any set of decisions made by the members of the credit committee. The assumption of homogeneous decisional skills is very common in the literature since along time skills tend to become homogeneous due to deliberation and effective learning processes, see, for example, Ben Yashar and Nitzan (2016).

It is plausible to resort to qualified majority rules since, by the main result in Nitzan and Paroush (1982) and Ben Yashar and Nitzan (1997), if individuals have an identical decisional skill p, the optimal decision rule is a qualified majority rule. A qualified majority rule is represented by an integer q, the quota required for the decision to be 1. That is, the committee decision is 1, if and only if the number of the credit committee members who support approval is larger than or equal to q. Note that $q=k+1$ represents the simple majority rule, $q=n$ represents a centralized decision rule, whereby the approval of all the credit committee members is required to approve a loan and $q=1$ represents a decentralized decision rule,

[5] R must be such that the entrepreneur participates in the loan program providing a positive expected income, i.e., $P_y(Y-R)>0$ and above the bank's cost of funds, otherwise the bank will never extend a loan.

[6] The guarantee g, can be interpreted as a percentage of loan repayment by assigning the value 1 to the loan repayment R, in which case the loan size is less than 1.

[7] Note that, $\frac{\partial\left(\frac{C-g}{R-g}\right)}{\partial g} = \frac{1}{(R-g)^2}(C-R) < 0$.

[8] In our setting, we can disregard the typical problems that arise in a classical social choice setting where preferences are heterogeneous (e.g., the difficulty of attaining a social compromise, (Young 1988, 1995) and the problem of majority tyranny, (Baharad and Nitzan 2002).

whereby the approval of only one credit committee member is required to approve a loan. In the trivial cases, the decision is made without consulting the committee when *q=0* (always approve) or when *q=n+1* (never approve). Note that although the credit committee members are assumed to be equally skilled, this does not imply that the optimal decision rule is the simple majority rule. In fact, as explained below and in the next section, despite the simplifying assumption, the set of potentially optimal decision rules is the spectrum of all possible qualified majority rules. The particular optimal qualified majority rule hinges on the environmental biases, viz., the a-prior probabilities and the net income from the possible states of the loan (good or bad).

3. The effect of government intervention on loan approval.

Given the parameter *q* that represents the qualified majority rule used by the credit committee, let us denote the probabilities that the committee approves a good loan and rejects a bad loan by $T(q:1)$, and $T(q:-1)$, respectively. Hence, the probability that a loan request is approved by the credit committee is denoted by $\Pr(1:q)$ where

$$\Pr(1:q) = \alpha T(q:1) + (1-\alpha)(1-T(q:-1)) \tag{1}$$

Note that 1-$T(q:-1)$ is the probability that the approved decision is incorrect.

We can establish that the guarantee enables the government to increase the probability that a loan is approved. Namely, the probability of approval increases with the magnitude of the government guarantee, that is: $\frac{\partial \Pr(1:q)}{\partial g} > 0$. This can be shown by recalling that given the decision rule *q*, the decision to approve a loan request requires the support of at least *q* committee members. Furthermore,

$$T(q:1) = \sum_{j=q}^{n} \binom{n}{j} p^j (1-p)^{n-j} \tag{2}$$

and

$$(1-T(q:-1)) = \sum_{j=q}^{n} \binom{n}{j} (1-p)^j p^{n-j} \tag{3}$$

Also,

$$\frac{\partial \Pr(1:q)}{\partial g} = \frac{\partial \alpha}{\partial g} T(q:1) - \frac{\partial \alpha}{\partial g}(1-T(q:-1)) = \frac{\partial \alpha}{\partial g}(T(q:1) - (1-T(q:-1))) = \frac{\partial \alpha}{\partial g} \sum_{j=q}^{n} \Delta_j \tag{4}$$

where $\Delta_j = \binom{n}{j}\{p^j (1-p)^{n-j} - (1-p)^j p^{n-j}\}$.

Since (a) $\partial\alpha / \partial g > 0$.

(b) $\forall j > \frac{n}{2}, \Delta_j > 0$.[9]

[9] $\Delta_j > 0 \Leftrightarrow \left(\frac{p}{1-p}\right)^j > \left(\frac{p}{1-p}\right)^{n-j} \Leftrightarrow j > n-j \Leftrightarrow j > n/2$. (Note that under the model's assumptions, p>1/2 and hence $p/(1-p) > 1$).

(c) $\forall j = a,\ \Delta_a = -\Delta_{n-a}$.[10]

If $q > n/2$, then by (a) and (b), $\frac{\partial \Pr(1:q)}{\partial g} > 0$. If $q < n/2$, then by (c), we know that, $\sum_{j=q}^{n} \Delta_j = \sum_{j=n-q+1}^{n} \Delta_j$. Since *n-q+1>n/2*, this last term is positive by (b), and with (a), $\frac{\partial \Pr(1:q)}{\partial g} > 0$.

Hence, the probability of approving a loan increases with government intervention due to the fact that the a-priori probability that a loan request is good increases when the threshold of good projects is reduced. The lower threshold is achieved by the government guarantee that reduces the loss to the bank in the event of a failed project. The implication is that, from the bank's point of view, it now faces a larger proportion of good loans. Hence, some loans that would have been rejected before the introduction of the guarantee are now approved.

Sometimes, however, given its budget framework, the government can only marginally change the loan guarantee. The structure of decision-making in the credit committee, i.e., the decision rule used to aggregate the decisions of the credit committee members is of crucial importance in determining the magnitude of the marginal effect of government intervention on the probability of loan approval. Our next result determines the decision rule that induces the maximal increase in lending in response to a marginal change in the guarantee *g* that has been chosen by the government.

THEOREM 1. *The effect of a change in the government guarantee on the probability of approving a loan varies symmetrically with the parameter q representing the qualified-majority rule applied by the credit committee. The change in the probability of loan approval is maximal at the simple majority rule and is minimal at the extreme centralized and decentralized qualified-majority rules. That is,*

$$\frac{\partial \Pr(1:q=k+1)}{\partial g} > \frac{\partial \Pr(1:q=k+1+i)}{\partial g} = \frac{\partial \Pr(1:q=k+1-i)}{\partial g} \quad \textit{and}$$

$$\frac{\partial\left(\frac{\partial \Pr(1:q=k+1+i)}{\partial g}\right)}{\partial i} < 0\text{, } \textit{where i is a positive integer.}$$

Proof. Recall that $\frac{\partial \Pr(1:q)}{\partial g} = \frac{\partial \alpha}{\partial g}\sum_{j=q}^{n}\Delta_j$, where $\Delta_j = \binom{n}{j}\left\{p^j(1-p)^{n-j} - (1-p)^j p^{n-j}\right\}$.

and (a) $\partial\alpha/\partial g > 0$.

(b) $\forall j > \frac{n}{2},\ \Delta_j > 0$.

(c) $\forall j = a,\ \Delta_a = -\Delta_{n-a}$.

By (b) $\sum_{j=k+1}^{n}\Delta_j > \sum_{j=k+1+i}^{n}\Delta_j$, hence,

$\frac{\partial \Pr(1:k+1)}{\partial g} > \frac{\partial \Pr(1:k+1+i)}{\partial g}$, where *i* is a positive integer.

[10] $\Delta_a = \binom{n}{a}\left[p^a(1-p)^{n-a} - (1-p)^a p^{n-a}\right]$ and $\Delta_{n-a} = \binom{n}{n-a}\left[p^{n-a}(1-p)^a - (1-p)^{n-a}p^a\right]$. Hence, $\Delta_a = -\Delta_{n-a}$.

By (c) above, if $q < \frac{n}{2}$ then $\sum_{j=q}^{n} \Delta_j = \sum_{j=n-q+1}^{n} \Delta_j$. Therefore,

$$\frac{\partial \Pr(1:q)}{\partial g} = \frac{\partial \Pr(1:n-q+1)}{\partial g}.$$

Specifically, this is true when $q = k+1-i$. Substituting $n = 2k+1$ yields, $n-(k+1-i)+1 = k+1+i$.

Hence, $\frac{\partial \Pr(1:k+1-i)}{\partial g} = \frac{\partial \Pr(1:k+1+i)}{\partial g}$. Furthermore, $\sum_{j=k+1+i}^{n} \Delta_j$ decreases with *i*. Therefore,

$$\frac{\partial\left(\frac{\partial \Pr(1:k+1+i)}{\partial g}\right)}{\partial i} < 0.$$

QED

THEOREM 1 implies that the structure of decision making in the credit committee determines the effectiveness of the marginal loan-guarantee program. The government can expect the greatest increase in the probability of loan approval when the simple majority rule is used to aggregate the decisions of the credit committee members. That is, the largest increase in lending corresponding to an increase in the guarantee is achieved when a simple majority rule is used. There is symmetry in the attainable effectiveness when moving away from the simple majority rule towards centralized and decentralized decision-making structures. In other words, as a bank is either more centralized or more decentralized in its credit committees' decision-making structure, a given increase in the guarantee will achieve a lower increase in lending and the government will have to offer a higher increase in the guarantee in order to achieve a target increase in lending. This is necessary since greater centralization (decentralization) requires more (less) support of decision makers and therefore it becomes more difficult to achieve a meaningful marginal effect.

Expanding on this result, note that the most extreme decision rules are the centralized decision rule and the decentralized decision rule. Under the former rule all decision makers are required to vote in favor of approving the loan while under the latter rule only one favorable decision maker is required to approve a loan. An increase in the guarantee produces an increase in the a priori probability. In the extreme case where all members need to vote in favor, a marginal change in the a priori probability will have only a small effect, since most projects are rejected. Similarly, in the extreme case where only one member is required to vote in favor of approving a loan, a marginal change in the a priori probability of loan approval will have only a small effect on the probability of loan approval since most projects are approved. Hence, in extreme cases of centralized and decentralized decision rules, large changes in the a priori probabilities are required, in order to affect the probability of loan approval. Conversely, in the less extreme cases, a small change in the a priori probability has a more meaningful effect, viz., it will produce a significant effect on the decision to approve a loan. A comprehensive discussion of extreme decision rules can be found in Ben-Yashar and Nitzan (2001) and Sah and Stiglitz (1986).

4. The effect of government intervention on the bank's decision structure.

The decision rule applied by the bank has a crucial impact on the success of the government's guarantee program. However, if the bank applies the optimal decision-making structure, the government must take into consideration that the guarantee may alter the bank's optimal decision rule. This in turn may affect the success that can be expected from the guarantee in terms of loan approval.

Without loss of generality, it is assumed that rejection of a loan request (good or bad) is associated with zero income for the bank. In the case of a particular good loan, where $P_y > \tau$, the bank's net expected income from that particular loan, *B(1),* is the difference between the expected income from approving it and from rejecting it. That is,

$$B(1)= P_y R + (1 - P_y) g - C - 0 > 0 \tag{5}$$

In the case of a particular bad loan, where $P_y < \tau$, the bank's net expected income from the loan, *B(-1),* is the difference between the expected income from rejecting it and from accepting it. That is,

$$B(-1)= 0 - (P_y R + (1 - P_y) g - C) > 0 \tag{6}$$

The optimal decision rule from the bank's point of view, which maximizes its expected income from its decision, is a qualified-majority rule, represented by $\hat{q}$, see, Nitzan and Paroush (1982, 1985) and Ben-Yashar and Nitzan (1997), where

$$\hat{q} = \frac{n}{2} - \frac{\delta + \lambda}{2 \ln\left(p / 1 - p\right)} \tag{7}$$

and $\lambda = \ln \frac{\alpha}{1-\alpha}$, $\delta = \ln \frac{EB(1)}{EB(-1)}$ where *EB(1)* and *EB(-1)* are the expected values of *B(1)* and *B(-1),* respectively.

Note that, λ and δ are bias components that determine the extent of the optimal bias towards approving or rejecting the loan. Recall that both of these biases are affected by the guarantee g set by the government. This framework of endogenous biases constitutes a significant extension of the above literature, where the biases are exogenous to the optimal decision rule. Note that, λ reflects the asymmetry in the priors of the two types of loans (a good loan and a bad loan) and δ reflects the asymmetry of the net expected incomes associated with the two types of loans. The biases contain information that is independent of the decisions of the individual committee members. Hence, the final decision concerning loan approval is based on two distinct types of information. The first type is loan specific (e.g., leverage of a specific borrower, the borrower's history, projected earnings, etc.) that is known to the individual committee members. This type of information determines for each committee member whether to vote in favor of loan acceptance. It is objective information in the sense that the government does not control it. The second type of information contained in the biases is general information concerning the environment in which the committee makes the decision. The environment reflects combined characteristics of the loan requests such as the percentage of good loans and the expected income from the pool of loans. Accordingly, when the board of directors relies heavily on the biases when choosing a decision structure, it reduces the reliance on the objective loan-specific information used by the committee members in approving a loan. This is crucial for financial stability which relies on appropriate use of all information and which can deteriorate when financial decisions are detached from fundamental information concerning borrowers.

In the symmetric case where *EB(1)=EB(-1)* and $\alpha = 1/2$, the bias elements vanish and the optimal decision rule is the simple majority rule, $\hat{q} = n/2$. In this case a decision is based only on objective (uncontrolled) information concerning the specific loan request as known to the individual committee members. If $\delta + \lambda > 0$, the bias is in favor of approving the loan request and, therefore, $\hat{q} < n/2$, i.e., less than half of the credit committee members are

required to decide in favor of the loan in order for an approval decision to be made thereby reducing the importance of loan specific information that may be known to individual decision makers concerning a specific loan. The decentralized structure presents the extreme case where the bias is very large, and only one credit committee member is required to make a positive decision. In this case, the final decision is certainly based more on the biases and less on the specific loan-related information known to the individual committee members. When $\delta+\lambda<0$, the bias is in favor of rejecting the loan request, and therefore $\hat{q}>n/2$. In the centralized structure, we observe the extreme situation in which all credit committee members must decide in favor of the loan in order for the loan to be approved thereby extremely reducing the importance of loan specific information that may be known to individual decision makers concerning a specific loan (since the requirement for the rejection of a loan request is minimal).[11] In this case too, the final decision is, again, certainly based more on the biases and less on the specific loan-related information known to the individual committee members.

4.1 An illustration: The Standard Uniform Distribution.

To illustrate the usefulness of our setting, henceforth let us assume that the distribution of P_y is uniform. The functions $f_1(P_y)$ and $f_2(P_y)$ denote the conditional distribution functions of P_y given that loans are good and bad, respectively. In this case we find that if g increases, the optimal structure of the bank's credit committee becomes more decentralized and hence more lenient toward approval of a loan, i.e., a smaller proportion of decision makers is necessary for approval of the loan. In the following proposition we focus on the optimal structure of the bank's credit committee[12].

PROPOSITION 1. $\dfrac{\partial\hat{q}}{\partial g}<0$.

Proof.

$$EB(1)=\int_{\frac{C-g}{R-g}}^{1}\left(P_yR+(1-P_y)g-C\right)f_1(P_y)dP_y=(R-g)\int_{\frac{C-g}{R-g}}^{1}P_y\,f_1(P_y)dP_y+g-C$$

$$=(R-g)\frac{1}{2}\left(1+\frac{C-g}{R-g}\right)+g-C=\frac{1}{2}(R-C).$$

$$EB(-1)=-\int_{0}^{\frac{C-g}{R-g}}\left(P_yR+(1-P_y)g-C\right)f_2(P_y)dP_y=-\left[(R-g)\int_{0}^{\frac{C-g}{R-g}}P_y\,f_2(P_y)dP_y+g-C\right]$$

$$=-\left[(R-g)\frac{1}{2}\left(\frac{C-g}{R-g}\right)+g-C\right]=\frac{1}{2}(C-g).$$

[11] There are two trivial cases where the decision is made without consulting the credit committee, that is, either always approve or never approve a loan, based only on the biases.

[12] Note that whereas in THEOREM 1, the focus is on the effect of the government guarantee on the probability of approving a loan, given a decision rule , in PROPOSITION 1 the focus is on the effect of the guarantee on the optimal decision rule.

It can be shown that $\frac{\partial EB(1)}{\partial g}=0$, $\frac{\partial EB(-1)}{\partial g}<0$ and it has been shown that $\frac{\partial \alpha}{\partial g}>0$. Since, $\delta=\ln\left(\frac{EB(1)}{EB(-1)}\right)$ and $\lambda=\ln\left(\frac{\alpha}{1-\alpha}\right)$,

$$\frac{\partial \delta}{\partial g}=\frac{1}{EB(1)EB(-1)}\left(\frac{\partial EB(1)}{\partial g}EB(-1)-\frac{\partial EB(-1)}{\partial g}EB(1)\right)>0 \text{ and } \quad \frac{\partial \lambda}{\partial g}=\frac{1}{\alpha(1-\alpha)}\frac{\partial \alpha}{\partial g}>0$$

Therefore, $\frac{\partial \hat{q}}{\partial g}=-\frac{1}{2\ln\left(\frac{p}{1-p}\right)}\frac{\partial(\delta+\lambda)}{\partial g}<0$.

QED

PROPOSITION 1 implies that, when the optimal decision rule is used and the guarantee is increased, fewer credit committee members are required to be in favor of a loan in order for the loan to be approved.

When a guarantee is introduced, the biases λ and δ change and hence the optimal rule is updated. In other words, government intervention affects the way in which the decisions of the credit committee members should be aggregated. Let us assume that $R > C > \frac{R}{2}$, namely the bank has relatively high lending costs that create a negative bias in the decision rule favoring loan rejection. The government can introduce a guarantee that weakens and perhaps eliminates the negative bias, increasing the probability of loan approval. However, if the guarantee is very high the government may find that it has created an unwarranted positive bias causing loan approval to be based too much on the bias and insufficiently on loan-specific information known to individual committee members.

Since the biases can reduce the reliance on objective loan-specific information known to individual committee members, the government may wish to prevent such insufficient reliance on information in the decision process, by setting the guarantee *g*, such that the sum of the biases equals zero. By doing so the government induces the bank to use the simple majority rule. Notice that any alternative qualified majority rule relies less on the objective information because it reduces the number of decisive decision makers, i.e., the minimal number of committee members whose decision determines the committee decision, either in favor or against loan approval.[13] The following result determines the guarantee, *g* that results in the selection of the simple majority rule and, hence, maximal reliance on the loan-specific information known to individual committee members in the loan approval decision.

THEOREM 2. *The simple majority rule becomes the optimal rule for the bank, if the government sets the guarantee* $g = 2C - R$. *In this case, the biases* λ and δ *are equal to zero.*

Proof. We need to show that if $g = 2C - R$, then $\lambda=\delta=0$ and hence the simple majority rule is the optimal one. If $g = 2C - R$, then $\tau = \left(\frac{C-g}{R-g}\right) = \left(\frac{R-C}{2(R-C)}\right) = \frac{1}{2}$. Hence, $\alpha = 0.5$. In this case, since the distribution of P_y is assumed to be uniform,

[13]For example, both under the extreme decentralized and centralized rules mentioned above, the number of decisive individuals is one. In the former case any individual can ensure the approval of a loan whereas in the latter case any individual can ensure the rejection of a loan.

$$EB(1) = \int_{\frac{1}{2}}^{1} \left(P_y R + (1-P_y)(2C-R) - C\right) f_1(P_y)\, dP_y$$

$$= 2(R-C)\int_{\frac{1}{2}}^{1} P_y\, f_1(P_y)\, dP_y + C - R = 2(R-C)\frac{3}{4} + C - R = \frac{1}{2}(R-C).$$

And,

$$EB(-1) = -\int_{0}^{\frac{1}{2}} \left(P_y R + (1-P_y)(2C-R) - C\right) f_2(P_y)\, dP_y .$$

$$= -2(R-C)\frac{1}{4} - C + R = \frac{1}{2}(R-C).$$

We have shown that $\alpha = 0.5$, and *EB(1)=EB(-1),* hence, $\lambda = \delta = 0$.

QED

We have illustrated how the government can set the guarantee at a level that induces the bank to choose the simple majority rule which results in the maximal marginal effect on the probability of loan approval while possibly preventing insufficient reliance on valuable information known to individual committee members concerning a specific loan request. In practice, a bank may have a minimum guarantee level at which it will be willing to participate in the credit guarantee scheme, as pointed out by Honohan (2010). In this case, it will not be possible for the government to introduce a guarantee that steers the bank towards the simple majority rule and information loss due to the biases will not be fully avoided.

In general, the optimal decision rule chosen by the bank to approve a loan request is based on the biases as well as on other objective information known to the committee members. Consider the case $\frac{R}{2} > C$, where the bank has relatively low lending costs that create a positive bias in the decision rule favoring loan approval.[14] The introduction of the guarantee in this case further strengthens this bias, again, causing loan approval to be based too much on the bias and insufficiently on loan-specific information which results in an increase of the probability of loan approval. A sufficiently high guarantee, which results in a high probability of loan approval, may from the bank's point of view justify even an extreme decision structure, viz., automatic approval of loan requests in which case the credit committee is abolished. In this case no objective valuable information is used and approval of loans is based only on the biases. However, the government and the public it represents may view things differently than the bank, giving rise to a moral hazard problem. This is because an increase in the probability of loan approval that results from a more lenient committee may imply insufficient reliance on objective (uncontrolled) information as well as approval of riskier loans that are more likely to default making the guarantee more costly for the government. Note that the government faces a cost only in cases where the lender defaults and cannot repay his loan. This moral hazard problem has been documented by Gropp, Gruendel and Guettler (2014) who show that the removal of government guarantees caused German savings banks to reduce credit risk by cutting off the riskiest borrowers from credit, hence demonstrating the association between government guarantees and credit risk. Moreover, they find that reduction in risk was due to tightening of lending standards and

[14] Systemic risk in the banking sector is reduced using risk-based minimum capital requirements which translate into higher costs for banks that undertake riskier loans. Within the framework of our model, using such a measure to increase the bank's cost, *C*, lowers the bank's positive bias towards approving risky loans.

importantly for our results, credit risk decreased more in banks for which the value of the guarantee was higher prior to discontinuing the guarantee.

A wider economic consequence of reliance on the government guarantee and the positive bias it creates increasing risky lending, is the possibility of a financial crisis in the economy. Brunnermeier (2009) explains the various mechanisms through which sub-prime lending and its securitization, including the use of inadequate information for credit rating, led to the U.S. crisis in 2007-2008. Mian and Sufi (2009) show that the expansion in the supply of mortgage credit in the U.S., led to a rapid increase in house prices from 2001 to 2005 and subsequent defaults from 2005 to 2007. They find areas in the U.S. where applicants were denied credit and later on were able to obtain mortgages. Subsequently house prices increased sharply followed by a large increase in default rates. Mian and Sufi (2011) show that a significant fraction of both the sharp rise in U.S. household leverage and the increase in defaults from 2006 to 2008 can be explained by homeowners borrowing against the increase in home equity. Thus, the government's decision on the guarantee involves a trade-off between increasing the scale of risky lending and insufficient reliance on objective loan-specific information.

5. Conclusions.

In this paper we have extended and applied the results in Ben Yashar and Nitzan (1997) and Nitzan and Paroush (1982) to the case of loan guarantees that are used by governments to overcome shortcomings in the credit market. By using a framework of endogenous biases instead of exogenous ones and adding to previous results, we are able to suggest new insights into such government programs. Notice that the new approach of endogenous biases has been demonstrated assuming homogenous decisional skills that are independent of the general environment that reflects the characteristics of the loan requests. The advantage of these simplifying assumptions is based not on the robustness of the results to more general settings, but on their effective instrumental role in illustrating the interrelationship between government loan guarantees and the bank's credit decision-making structure.

The structure of decision-making in banks has been shown to be a crucial factor in determining the effect of government loan programs on the extent of lending. In essence our results point to the conclusion that, when operating a loan-guarantee program, governments marginally varying the loan guarantee can achieve the largest increase in lending and the maximal reliance on objective relevant information when facing banks that have neither centralized nor decentralized decision-making structures. This has important policy implications for governments planning such programs and taking into account their anticipated impact on weaker borrowers.

If the government is aware of the relationship between the parameters of the decision structure and the optimal qualified majority rule applied by the credit committee, then it can exploit its advantage to set the most effective loan guarantee that induces maximal lending. This policy will result in extreme decentralization, whereby only one credit committee member is required to make an approval decision or in the extreme case where the credit committee is not consulted for loan approval. The government may face therefore a trade-off between increasing the scale of lending and insufficient reliance on important information.

Our results have interesting implications regarding the effect of the guarantee on risk. The uncertain dichotomous choice decision model we have used allows us to explain such phenomena as sub-prime loans and information loss in the lending-decision process. This suggests a useful theoretical framework for demonstrating the moral hazard associated with government guarantees and clarifies how the government can prevent this specific problem through its choice of a guarantee. On the one hand, the bank is affected by the guarantee such that its threshold is lowered, causing approval of riskier loans. On the other hand, the decision rule is affected by the guarantee such that valuable information may not be taken into account

when the decision whether to approve a loan or reject it relies more heavily on the biases and less on the objective relevant information known to the members of the credit committee. The possible dilemma faced by the government due to these two effects of the guarantee can be solved by applying an objective function that takes into consideration the positive effect of the guarantee on lending as well as the negative effect of the guarantee on risk due to insufficient reliance on loan-specific information and on the cost faced by the government due to the guarantee. A solution of the optimization problem based on this objective function may allow the government to choose the guarantee that serves the public in the best way.

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