# COLLATERAL, CREDIT RATIONING AND THE REAL EFFECTS OF MONETARY POLICY

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## INTRODUCTION

The way monetary policy affects real economic activity has been a subject of discussion for decades. The conventional view is that monetary fluctuations, through interest rates, affect real output as a consequence of wage rigidities or imperfect expectations for instance. Since World War II, however, despite the empirical correlations observed between money and output fluctuations, neither significant movements in anticipated real rates nor large interest elasticities of spending have been apparent.

Recent empirical evidence has suggested that besides this standard interest rate effect monetary policy might also have a volume effect. Monetary policy would not only affect investment and output through variations in the interest rate, but also through the amount of bank lending by influencing the quantity of funds that banks may obtain. Firms heavily dependent on banks for their external financing would in this case see their access to credit deteriorate during periods of restrictive monetary policy. As a consequence, the effects of monetary policy would not be evenly spread across the economy, but certain types of firms or certain segments of the economy would be more seriously affected than others.

Examining from 1960 to 1991 the responses of 7'000 US manufacturing firms to monetary policy, GERTLER and GILCHRIST (1992 and 1994) have noticed indeed that, following interest rate increases, bank loans to small firms tend to decline significantly, while short-term debt of larger ones may even rise. KASHYAP and STEIN (1993) cite studies on Japan and on the United States confirming this view: during periods in which monetary policy is tight, bank-dependent firms' spending becomes more closely tied to the availability of internal finance.

The conventional view of monetary policy transmission, as embodied in the IS-LM model, is based on the concepts that loans and bonds are perfect substitutes and that financial markets clear only by prices. Models generating a lending channel for monetary

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policy can therefore be built by dropping either of these two assumptions. BERNANKE and GERTLER (1987) and BERNANKE and BLINDER (1988), for example, have assumed that only some enterprises could tap the bond market, while all the others depended upon banks for their external financing. KING (1986), BLINDER (1987) and GERTLER and GILCHRIST (1994) have by contrast built upon the contribution of BLINDER and STIGLITZ (1983) and assumed credit rationing.

Although the identification of the firms vulnerable to real effects of monetary policy is a key element in determining the macroeconomic implications of this channel, this has been assumed a priori in all these models. BLINDER (1987) assumes that credit rationing affects all enterprises uniformly, while in GERTLER and GILCHRIST (1994) only small firms are rationed. BLINDER and STIGLITZ (1983) do not present any formal model, but suggest that high-risk borrowers would face a deterioration in their access to credit in case of restrictive monetary policy. The purpose of this paper is to improve the identification of the firms affected by the credit channel by endogenizing this asymmetry. For this, a simple competitive credit rationing model with limited collateral will be used.

The paper will proceed as follows. Section 1 will briefly overview the theoretical foundations linking collateral and access to credit in an imperfect information setting. Section 2 will then present an extension of a simple competitive credit rationing model to include monetary policy and its equilibria. Section 3 will then discuss the effects of monetary policy in this setting.

## 1. ACCESS TO BANK CREDIT AND THE ROLE OF COLLATERAL

### *1.1 Informational asymmetries*

Financial institutions operate in settings where complete information is often unavailable. Entrepreneurs seeking financing normally have more information about their projects and greater control over them than do their fund providers. Two main informational asymmetries have been distinguished in relation to the fund provider's financing decisions.

Ex ante asymmetries occur prior to this decision. There may be, for instance, several types of entrepreneurs differing with respect to their probability of default but indistinguishable from the fund providers' viewpoint.

Ex post asymmetries occur after the fund provider's decision to finance an entrepreneur. The latter may adversely affect through his behaviour the probability that he repays his financiers. By investing less effort, for instance, he may render a successful outcome less likely. Alternatively, the entrepreneur may choose another project, riskier than the one for which the financing was granted. A lower effort increases the entrepreneurs' utility. A riskier project yields a higher return in case of success.

This change in behaviour cannot be observed, however, by the fund provider or, if it can, only at a very high cost. The non-observability therefore introduces an incentive

problem, whereby the entrepreneur, once funded, is incited to change his behaviour to maximize his utility, but at the cost of reducing that of his financier.

Ex ante asymmetries require a screening effort in order for the fund provider, when faced with projects yielding identical expected returns for instance, to distinguish the low- from the high-risk ones and grant loans only to the former. To limit incentive problems, financiers have either to devise contracts inducing the entrepreneurs to adopt the desired behaviour or devote resources to check his activities. This paper will focus on the screening problem.

### *1.2 Screening and the role of collateral*

In a perfect information setting, fund providers, observing the expected returns on projects and their probability of failure, can simply select among those yielding identical expected returns the least risky ones. In an imperfect information environment, by contrast, expected returns or probabilities of success cannot be observed. Financiers have to find devices to distinguish projects.

One possibility could be to use interest rates. As STIGLITZ and WEISS (1981) demonstrated however, increases in the interest rate charged on loans may lead to adverse effects on the pool composition of borrowers. For a given expected return, an increase in interest rates will induce low-risk projects to drop out first, keeping only the riskier ones in the pool.

The intuitive reason for this is the following. Entrepreneurs are more concerned with servicing their debts in case of success than in case of failure. In case of failure, any revenue their project may generate is assumed to be insufficient to even cover the repayment of the principal. They are compelled to declare bankruptcy. Their decision to accept a loan contract will therefore depend on the return their project yields in case of success. The riskier the project, the higher this outcome will be.

Lenders could use collateral requirements to alleviate this problem. The intuition is that by asking for collateral, the lender creates a cost for the entrepreneur in case of default. As the probability of failure is greater for high-risk projects, the same amount of collateral will reduce the expected profit of these projects by more than it will reduce that of less risky ones.

STIGLITZ and WEISS (1981) showed, however, that in a monopolistic loan market collateral turns out to play a very limited role. For a given interest rate, collateral requirements themselves could induce an adverse selection process (WETTE, 1983). In case of proportional collateralization costs, the lender disregarded collateral altogether (CLEMENZ, 1986).

In a competitive setting, however, BESTER (1985) demonstrated that lenders could design a low- and a high-risk contract inducing borrowers to self-select themselves and leading to perfect sorting. Low-risk entrepreneurs, more concerned with achieving a successful outcome, would prefer a contract carrying a low interest rate and requiring a

high level of collateral. High-risk entrepreneurs, facing a higher probability of loosing their collateral, would opt by contrast for a contract carrying a higher interest rate but requiring lower collateral.

However, as BESANKO and THAKOR (1987) pointed out, these results hold provided entrepreneurs are unconstrained with respect to the amount of collateral they can put up. If collateral is constrained, perfect sorting may not be achievable and rationing would re-emerge. This paper builds on these last two contributions by extending the model to include monetary policy.

## 2. MODEL

### *2.1 Entrepreneurs*

The model describes a competitive credit market with numerous entrepreneurs and lenders. All agents are assumed risk neutral. There are only two projects (1 and 2) available in the economy, identified by their probability of success $\pi_j$, $j = 1,2$, with $\pi_1 > \pi_2$. Each project yields a positive return if successful ($R_1$, $R_2$) and zero otherwise, with $\pi_1 R_1 = \pi_2 R_2$ and $R_2 > R_1$. A proportion $\alpha$ of the population is endowed with a low-risk type 1 project, while the rest faces a high-risk type 2.

Projects 1 and 2 require a fixed amount of investment $B$. Entrepreneurs are endowed with an initial net worth $W$. These resources are however fixed in illiquid assets. In order to undertake their projects, entrepreneurs have thus to borrow the total amount $B$, on which they have to pay an interest $r_j$, $j$=1, 2. However, provided they pay a proportional collateralization cost $k$, they can put up their net worth as collateral. The loan will be assumed to be not fully collateralized, so that the lender faces a risk. If the project fails, the entrepreneur cannot meet his obligations and defaults. In this case, the lender receives the collateral.

Besides the interest rate and the collateral requirement, a loan contract will also be defined by an acceptance probability, $p_j$, $j = 1, 2$. Finally, when undertaking the project, entrepreneurs face an opportunity cost $Z$, which can be viewed as the satisfaction provided by an alternative activity or the amount of disutility generated by the effort to be invested in the project. Entrepreneurs are assumed to be able to apply for only one loan contract. The expected utility of entrepreneurs $i$ applying for a loan contract devised for group $j$ will therefore be:

$$U_{ij} = p_j\left[\pi_i[R_i - (1 + r_j)\, B] - (1 - \pi_i)\, C_j - kC_j - Z\right] \qquad i, j = 1, 2 \qquad (1)$$

### 2.2 *Lenders*

Lenders face an infinitely elastic supply of funds provided by the central bank at the constant interest rate ρ. They offer loans characterized by an interest rate ($r$), a collateral requirement ($C$) and a probability of granting the loan ($p$). If entrepreneurs succeed, lenders get their interest on the loan and the principal. If the project fails and the borrower defaults, they only get the collateral. Competition among lenders will generate the following zero-profit condition on loans to each group:

$$\rho = \pi_j (1 + r_j) + (1 - \pi_j) \frac{C_j}{B} \qquad j = 1,2 \qquad (2)$$

While the proportion of low- and high-risk entrepreneurs is known, the exact identity of an individual entrepreneur is however unobservable. Lenders will therefore try to design loan contracts $\{r_j ; C_j ; p_j\}, j = 1,2$, generating a self-selection process: each entrepreneur type will choose the contract specially devised for him. In addition to the zero-profit constraint described in (2), lenders will have therefore to take into account a pair of incentive-compatibility constraints:

$$U_{12} \leq U_{11} \qquad (3a)$$

$$U_{21} \leq U_{22} \qquad (3b)$$

where $U_{ij}$ has been defined in (1). Each type of borrower should prefer the contract specially devised for him.

## 3. EQUILIBRIA

### 3.1 *Unconstrained collateral*

I will first assume that both types of entrepreneurs are unconstrained with respect to the amount of collateral they can put up (i.e. $C_j < W, j = 1,2$). Lenders cannot distinguish the type of the entrepreneurs. They have therefore to set the conditions of their loan contracts by maximizing the population-weighted average of entrepreneurs' expected utility, given by:

$$U = \alpha U_{11} + (1-\alpha) U_{22} \qquad (4)$$

subject to (2), (3a) and (3b). This yields the following equilibrium:

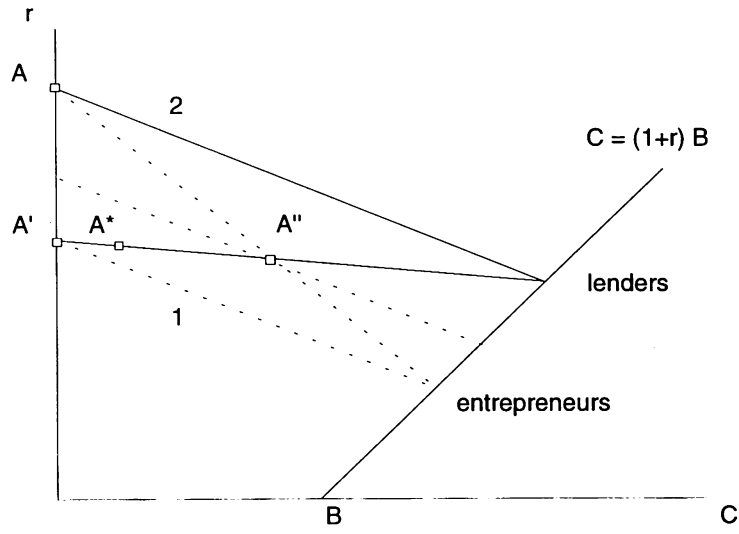
$$p_1 = 1 \qquad p_2 = 1$$

$$C_1 = \frac{\pi_1 - \pi_2}{(1+k)\pi_1 - \pi_2}\rho B \qquad C_2 = 0$$

$$(1+r_1) = \frac{\rho}{\pi_1} - \left(\frac{1-\pi_1}{\pi_1}\right)\frac{C_1}{B} \qquad (1+r_2) = \frac{\rho}{\pi_2}$$

Lenders are able to design a distinct contract for each group of entrepreneurs. High-risk borrowers will be proposed a loan carrying a relatively high interest rate ($1 + r_2 > 1 + r_1$) but requiring no collateral. Perfect sorting is feasible and no credit rationing occurs ($p_j = 1, j = 1,2$).

**Figure 1**




Graphically, the equilibrium is depicted in Figure 1. Partially differentiating lenders' profit and entrepreneurs' iso-utility functions with respect to the interest rate, $r$, and the collateral requirement, $C$, yields:

Lenders: $$\frac{dr}{dC} = -\frac{(1-\pi)}{\pi B}$$

Entrepreneurs: $$\frac{dr}{dC} = -\frac{(1-\pi+k)}{\pi B}$$

Since $k > 0$, $(1 - \pi + k) > (1 - \pi)$. The slope of the lenders' profit function, represented by full lines, is therefore flatter than that of the entrepreneurs' iso-utility, drawn as dashed lines. In addition, as $\pi_1 > \pi_2$, the slopes referring to the low-risk project will be flatter than those for the high-risk ones.

The equilibrium contracts are represented by A (high-risk contract) and A" (low-risk contract). The highest high-risk iso-utility curve the lenders can reach, while satisfying their zero-profit constraint, is indeed at point A, defined by an interest rate $1 + r = \rho/\pi_2$ and zero collateral. All the other points on this zero-profit schedule would intersect iso-utility curves cutting from above (i.e. representing lower levels of utility for the high-risk entrepreneurs).

A similar contract for low-risk borrowers at point A' is however not feasible, since it would not be incentive compatible. High-risk entrepreneurs would be better off applying for the low-risk contract A'. Lenders will therefore have to make this low-risk contract less attractive for high-risk borrowers. Raising collateral requirements will discourage high-risk entrepreneurs more than low-risk ones, since the former have a higher probability of actually paying this higher cost.

Collateral requirements will thus be increased up to the point where the incentive-compatibility constraints are satisfied. This condition is reached at A": at the intersection point between the lenders' zero-profit schedule for low-risk projects and the high-risk iso-utility curve crossing point A. At this point, high-risk entrepreneurs are indifferent between the two contracts and the highest low-risk iso-utility schedule is reached.

### *3.2 Constrained collateral*

Following BESANKO and THAKOR (1987), I will now assume that low-risk entrepreneurs are constrained with respect to the amount of collateral they can put up, so that they cannot apply for the low-risk incentive compatible contract A" anymore. Lenders will be obliged to offer another low-risk contract, requiring a lower level of collateral than at A", A* for instance. This new contract will, however, not be incentive compatible: it will tend to attract both types of entrepreneurs.

Therefore, the lenders have to find a device in order to make this new low-risk contract less attractive to high-risk borrowers. Raising the interest rate, $r_1$, will discourage low-risk entrepreneurs more than high-risk ones, since for the former the probability is higher that they will actually have to pay this higher rate. The alternative is to reduce p, i.e. not satisfy all loan applicants.

In refusing to grant credit to some applicants to the low-risk loan, lenders introduce an additional uncertainty that reduces the expected utility of applying for this new contract. This lower expected utility, while keeping the interest of low-risk entrepreneurs (since they have no other alternative[1]), will discourage high-risk ones: the wedge between high-risk borrowers' expected utility provided by the low-risk contract, A*, and that offered by the high-risk one, A, has narrowed. This wedge could even disappear, removing all incentive for high-risk borrowers to prefer low-risk contracts, if the lenders' acceptance probability, $p_1$, is set low enough. The maximization problem subject to the additional constraint $C_1 = W$ will yield the following equilibrium:

$$p_1 = \frac{U_{22}}{\pi_2[R_2 - (1 + r_1)\,B] - (1 - \pi_2 + k)\,W - Z} < 1 \qquad p_2 = 1$$

$$C_1 = W \qquad C_2 = 0$$

$$(1 + r_1) = \frac{\rho}{\pi_1} - \left(\frac{1 - \pi_1}{\pi_1}\right)\frac{W}{B} \qquad (1 + r_2) = \frac{\rho}{\pi_2}$$

## 4. MONETARY POLICY

What would be the effects of monetary policy in such a setting? A change in monetary policy would translate itself by a modification in the interest rate charged on central bank financing, ρ. Differentiating the different elements of the loan contract in the unconstrained equilibrium yields:

$$\frac{dC_1}{d\rho} > 0$$

$$\frac{d(1 + r_1)}{d\rho} > 0$$

$$\frac{d(1 + r_2)}{d\rho} > 0$$

A tighter monetary stance adopted by the central bank would simply raise the interest rates paid on both loan contracts and the collateral required from low-risk entrepreneurs. No volume effects would be observed in addition to the standard interest rate effects.

1. The alternative high-risk contract, A, would yield a negative expected utility for low-risk entrepreneurs.

In the constrained equilibrium, however, lenders are unable to increase the amount of collateral they require from low-risk entrepreneurs. Without this increase in collateral, the raise in the interest rate charged on the low-risk contract will not be enough to offset the effects of the higher interest rate on the high-risk contract. With a higher interest rate charged on their high-risk contract, A, high-risk entrepreneurs would now be better off applying for the low-risk contract. The incentive compatibility constraint is not satisfied.

Increasing the interest rate, $r_1$, further will discourage low-risk entrepreneurs more than high-risk ones, since the probability is lower that the latter will actually end up paying this higher rate. In order for the incentive-compatibility constraints to hold again, the only variable that lenders can alter is $p$: the extent of credit rationing. Lenders will reduce the attractiveness of the low-risk contract to high-risk borrowers by reducing $p_1$, the number of applicants actually obtaining this contract. In addition to the standard increase in loan interest rates, in this case a restrictive monetary policy would also have a volume effect. Indeed partially differentiating $p_1$ with respect to $\rho$ yields:

$$\frac{dp_1}{d\rho} < 0$$

The results of the model tend to show therefore that the credit channel does not affect all entrepreneurs uniformly as BLINDER (1987) assumed. Small firms, constrained with respect to the amount of collateral they can put up, will be more exposed. In addition, the lending channel also modifies the quality composition of the pool of projects being financed. But in contrast to what BLINDER and STIGLITZ (1983) have suggested, the real effects of monetary policy tend to fall exclusively on low-risk enterprises, high-risk borrowers turning out in this model to be only affected by the standard interest rate effect.

Without rationing, all loan applicants are granted a credit. Lenders' portfolio will thus include low- and high-risk projects in the same proportion than their distribution among the population: $\alpha$ and $(1 - \alpha)$. As rationing of low-risk projects increases, the proportion of high-risk ones in this portfolio will grow. The average project which is financed will therefore yield a higher return in case of success, but carry a higher probability of failure. A restrictive monetary policy will thus, through the credit channel, also have an influence on the volatility of the economy.

## CONCLUSIONS

Instead of assuming a priori that certain firms were dependent upon banks or credit-rationed, this paper tried to generate endogenously this difference in access to credit. For this, a simple competitive credit rationing model with limited collateral was used and extended to include a central bank financing facility.

Contrary to current intuition, firms constrained with respect to the amount of collateralizable net wealth and endowed with low-risk projects turned out to be the most likely to suffer a deterioration in their access to credit following a tightening in monetary policy. The size effect is consistent with recent empirical studies showing that the burden of dearer money falls more heavily on small and medium-sized enterprises. The high-risk bias introduced in the composition of the pool of projects being financed suggests in addition that a restrictive monetary stance would lead, through the credit channel, to increased volatility.

With a view to further empirical investigations, the model presented in this paper would also suggest that, besides differences in sizes, differences across economic sectors could be detected. Sectors characterized by high levels of tangible assets, easily put up as collateral (e.g. land, buildings), would suffer less from lost access to credit than sectors where most of corporate value is embodied in intangible assets, such as goodwill or licences for instance. Real monetary effects would have therefore a higher chance of being observable in services, for example, rather than in manufacturing.

In addition, the importance of the credit channel turned out in this model to be function of the extent of credit rationing and thus of the amount of collateral a firm could put up. Adverse shocks on collateralizable net wealth would therefore increase the vulnerability of firms to this channel of transmission for monetary policy. These results would suggest that real effects would be more pronounced in periods of economic recession (when real estate markets are depressed for instance). This conclusion is consistent with the observations presented by GERTLER and GILCHRIST (1994). The response of small US manufacturing firms seemed to be asymmetric over the business cycle: stronger in bad times.

Finally, set in a dynamic framework, this asymmetry would suggest that if, monetary policy were to be restrictive for long periods of time, the economic structure of a country could itself be modified. Firms and sectors less affected by monetary policy would prosper at the expense of those who face a deterioration in their access to credit.

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## SUMMARY

This paper tries to improve the identification of firms whose access to bank credit would be threatened by a tightening of monetary policy. It extends a simple competitive credit rationing model with limited collateral by introducing a central bank financing facility. The effects of monetary policy are then examined. Besides the standard interest rate effect, the study shows that a tighter monetary policy would reduce bank lending to entrepreneurs endowed with low-risk projects and limited net wealth. In addition, the economy would become more volatile.

## ZUSAMMENFASSUNG

Dieses Papier will die Identifikation derjenigen Firmen erleichtern, die im Falle einer Verschärfung der Geldpolitik von einer fallenden Kreditvergabe betroffen würden. Es

erweitert das für vollständigen Wettbewerb verwendete Modell der Kreditrationierung mit limitierter Kreditsicherheit durch die Einführung einer Kreditlinie der Notenbank. Die Auswirkungen der Geldpolitik werden anschliessend geprüft. Die Studie zeigt auf, dass eine Verschärfung der Geldpolitik nicht nur die Zinsen betrifft, sondern auch die Kreditvergabe an Unternehmen mit risikoarmen Projekten und beschränkten Mitteln. Zudem würde die Wirtschaft vermehrten Schwankungen ausgesetzt.

## RESUME

Ce papier essaie d'améliorer l'identification des entreprises susceptibles de voir leur accès au crédit se détériorer lors d'un resserrement de la politique monétaire. Il utilise un modèle de rationnement de crédit en situation de concurrence avec collatéral limité et introduit une facilité de financement de la banque centrale. Les effets de la politique monétaire sont ensuite examinés. Le papier montre qu'un resserrement de la politique monétaire a non seulement une influence sur le taux d'intérêt, mais également sur la quantité de crédits alloués aux entrepreneurs ayant des projets peu risqués et une richesse limitée. En outre, l'économie deviendrait plus volatile.