ON CREDIT RATIONING AND BANKING FIRM BEHAVIOR

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Abstract: The paper discusses some aspects of the banking firm behavior related to credit rationing (CR) models. It shows that credit rationing solutions depend decisively on the hypothesis of indivisibility of the credit required by the entrepreneurs, on the same (average) expected return of the investment projects and on the type of credit contract. The paper also shows that the credit rationing models cannot explain adequately the banking firm behavior related to the business cycles, especially in booms. During these times, according to this model, the banker constraints the credit to the borrowers. The paper, thus, suggests a theory of the banking firm behavior related to financial structures in Minsky's sense, where the notion of sacrifice ratio – that is, the degree of commitment of the borrower's expected revenue – plays a central role in determining the amount of credit to be advanced.

1. Introduction

The Stiglitz and Weiss (1981) model of banking firm is an attempt to deal with the informational problems concerning the advance of credit. On the microeconomic side, the main idea behind their model is to show that the asymmetric information between lenders and borrowers that characterize credit markets can give rise to *equilibrium* credit rationing.

This result is essentially based on one theorem that states the rate of interest charged affects the "nature of the transaction", that is, the probability of success of a investment project will decrease as interest rate rises. As consequence, the relationship between interest rate and probability of success of a investment project is nonmonotonical. This theorem is follows directly from the hypothesis that the information asymmetries prevent the bank to distinguish between borrowers in terms of the *true* expected value of their projects. As a result, all projects have the same expected value from the bank's point of view.

Another aspect of the Stiglitz and Weiss model that deserves some attention is the hypothesis concerning the type of debt contract. In order to "simplify" the arguments, the authors assume these contracts are of a "standard debt form", on which the borrower pays the principal and the interest altogether on the next period. Thus, once the bank is less informed than borrowers and the debt contracts are of a standard debt form, the interest rate can be seen as a screening device for the bank. Consequently, it may not clear the market and credit is rationed.

We will argue that these two hypotheses are implausible. Firstly, in a dynamic world higher returns are not ineluctable related to lower probability of success as stated by the authors. It is easy to see that better expectations can lead to a situation characterized by higher returns **and** higher (expected) probability of success. Secondly, a typical debt contract is characterized by a series of payments (installments) of principal and interest. Consequently, the probability of success of a project must be related to (i) the size of the expected revenue of the project and (ii) the size of the ratio financial commitment to the expected revenue. As a result, there is no ineluctable relationship between higher revenues of success and higher risk and interest rate cannot be considered a screening device anymore.

The paper, thus, shows a credit rationing solution under more plausible hypotheses than the Stiglitz and Weiss's ones. In the next section, we present the main conclusions concerning Stiglitz and Weiss model with indistinguishable borrowers, that is, borrowers whose projects have identical expected return. In section 3 we extend this model to a situation where the lender is able to distinguish groups of borrowers but it is not able to distinguish borrowers inside a same group. Section 4 presents some critical remarks of both models - especially the model of section 3. It also presents our model of credit rationing. Section 5 presents some conclusions.

2. Credit rationing with indistinguishable borrowers

The credit rationing model developed by Stiglitz and Weiss - hereafter S-W - is based essentially on two hypothesis: (1) there is asymmetric (imperfect) information concerning the probability distribution of the outcome of the investment projects; and (2) the loans are balloon-type loans, that is, all the amount borrowed is paid by one payment at the end of the contract.

Hypothesis 1 states that each project has a probability distribution of gross returns known only by borrowers. As a consequence, the bank is only able to distinguish projects with different mean returns. It knows, however, they differ in risk but it cannot ascertain the *true* riskiness of the projects. The model also assumes that each project yields S_i when succeed and F -- equal for all project -- when fail, which could be zero. The probability of success is s_i. The expected (gross) return, E, of a project to the entrepreneur is given by

$$s_i S_i + (1-s_i)F = E, \qquad \text{for all } i. \tag{1}$$

From equation (1) we can derive the main corollary of the S-W model, that is, "the expected (certainty equivalent) return received by the lender does not increase monotonically with the rate of interest charged." (Jaffee and Stiglitz, 1990, p. 854). Thus, credit rationing will occur if, at the quoted interest rate, there is excess demand for credit. Despite this situation, the bank will not raise the interest rate charged because doing so only reduces the return it receives.

The nonmonotonic relationship between interest rate and expected return to the bank is a consequence of the direct effect of interest rate movements on the probability of success of the project. In other words, the S-W model assumes that the probability of success of the project is inversely related to the interest rate charged.

In formal terms, it is a consequence of the asymmetric information that prevents banks to choose adequately between borrowers. Since the expected return is the same for all projects, higher S_i are ineluctable related to lower s_i. This relationship is termed adverse selection effect or adverse incentive effect. In other words, since higher interest rates decrease the return of successful projects, "higher interest rates induce firms to undertake projects with lower probabilities of success but higher payoffs when successful." (Stiglitz and Weiss, 1981, p. 393).

Thus, the bank knows that raising the interest rate has two effects: a positive effect, represented by the higher direct return if the projects succeed, and a negative effect on the probability of success of the projects. According to the probability distribution of the return of the projects, there is an interest rate above which the marginal positive effect on the expected return of the banking firm is offset by the negative marginal effect.

It is also important to notice that the credit rationing depends decisively on another hypothesis: the indivisibility of the amount borrowed, B, which is equal for all borrowers. As interest rate rises, the bank cannot marginally adjust the *value* of the demand for credit; it has to select entire projects. However, as a consequence of the adverse selection and adverse incentive effects, this choice adversely affects the expected return to the bank.

More formally, the model assumes that the entrepreneur has a wealth endowment W insufficient to undertake the desired investment project that costs K. Thus, he/she needs to borrow K - W = B in order to undertake the project. As mentioned, the loan contract obliges the borrower to pay $(1 + r)$B at the end of the period if the project succeeds. In case of bankruptcy, the lender receives F. For one borrower, the expected return to the bank is given by

$$E(\pi_i) = s_i\,(1 + r)B + (1 - s_i)F, \quad \text{for all } i. \tag{2}$$

From equations (1) and (2) it is clear that

$$S_i > (1 + r)B > F, \quad \text{for all } i. \tag{3}$$

On the other side, as interest rate rises, safer borrowers are less able to apply for loans. As can be seen from the equation (4) below, only projects with higher S are able to pay more for a loan. However, as showed by equation (1), higher S is related to lower s. Thus, "[only] high-risk investors are willing to pay more for a loan." (Blanchard and Fischer, 1989, p. 481). Specifically, the (net) expected return to the entrepreneur in case of success is given by

$$E(\varphi_S) = s_i[S_i - (1 + r)B], \quad \text{for all } i. \tag{4}$$

In case of bankruptcy, the net return is:

$$E(\varphi_F) = (1 - s_i)(F - F) = 0, \quad \text{for all } i. \tag{5}$$

Equations (1), (4) and (5) show the rationale of credit rationing. Given B, higher interest rates will require higher S_i in order to generate a positive net return to the borrower. Although the bank is not able to sort entrepreneurs into probability classes - *i.e.* given E -, it knows that higher S_i will be associated to lower s_i. Then, the expected return to the bank is a concave function of the return of the project, as well as the supply of credit. In other words, as interest rate rises, the expected return to the bank will increase at a decreasing rate until the negative effect of lowest s_i equals the positive effect of highest r. That is, $dE(\pi_i)/dr > 0$ and $dE(\pi_i)/ds_i > 0$. However, $ds_i/dr < 0$. As a consequence, the supply of credit will increase nonmonotonically -- *i.e.* at a decreasing rate - as interest rate rises.

Assuming that both the bank and the entrepreneur are risk neutral, that there is a continuum of projects and that the probability of success effectively considered by the bank is higher than zero and less than one - that is, $0 \leq s_i \leq 1$, but once there are not riskless projects, as all projects have any probability to succeed, $0 < s_i < s$, where $0 < s < 1$ - credit rationing will always occur as the interest rate that maximizes the expected (gross) return to the bank[1] lead to a supply of credit less than the demand for credit. This is an equilibrium solution since there is not any mechanism that endogenously leads the interest rate to the level that balances supply to demand.

3. Credit rationing with many groups

As mentioned, the above solution is applied when borrowers are apparently identical. However, S-W model can be extended to situations where there are *n* observationally distinguished borrowers. This solution is termed "redlining" by Jaffee and Stiglitz (*idem*, p.859).

In this solution, there is an explicit cost of loanable funds equal to ρ. The expected net return to the bank is now given by

$$E(\phi) = (1 + r)B\int_0^s s_i f(s_i)ds_i + F\int_0^s (1 - s_i)f(s_i)ds_i - (1+\rho)B\int_0^s f(s_i)ds_i \qquad (6)$$

where $f(s_i)$ is the density function of the probability of success.

It is implicitly assumed that the bank is able to distinguish borrowers in terms of the expected gross return of their investment projects. In other words, the bank knows that the projects differ in risk and this difference is now translated into different expected gross returns. Inside each group, the bank can observe the nonmonotonic relationship between interest rate and the expected return of each project, exactly like the model presented in the above section.

Since the bank is constrained by the interest rate paid to the depositors, it has to charge an interest rate that maximizes (6). Given the expected net return of each group, some groups may be dropped out of the market since, at the quoted interest rate, the bank does not maximize its return.

In other words, in spite of the fact that the expected gross return are the same for all projects inside each group, the bank utilizes different values for s, s_i and $f(s_i)$ as a way to classify the projects. For this reason, bank's expected return is different for each group. Thus, an interest rate that maximizes the expected return to the bank in a group does not necessarily maximize its return in another.

As a consequence, given the quoted interest rate, the groups are divided into three categories (*cf.* Jaffee and Stiglitz, *ibid*., p. 859-60). Type 1 borrowers, are completed denied credit ("redlined"). Type 3 are fully served (no credit ration occur into this group) and type 2 borrowers are credit rationed in the pure sense, namely, some apparently identical borrowers receive credit and others do not. This group is termed *marginal group* since all movements in interest rate has a first impact on it[2].

Jaffee and Stiglitz also state that the redlining model and pure credit rationing model may be indistinguishable when there is a continuum of groups (*ibid*., p. 860). In this case, the features of the groups just above and below the marginal group will converge and the bank is unable to distinguish between them. "Consequently, the situation is effectively one of pure credit rationing, namely, that among groups of (nearly) indistinguishable borrowers some are credit rationed and some are not." (*ibid*.).

The model also describes some "comparative statics" of credit rationing. In case of changes in the uncertainty concerning the return of the projects (*e.g.* a recession), "it is plausible that the expected return falls, given the quoted interest rate." In spite of falling returns, however, the quoted interest at which the return of the bank is maximized will either increase or decrease.

This ambiguous solution is illustrated with the case where there are only two types of projects: project *a*, the safe one, and project *b* the risky one. Consequently, $S_a < S_b$ and $s_a > s_b$. Assuming also the loan size B is equal to 1 and the unsuccessful outcome for both project is 0, the expected gross return for each project is given by

$$s_a\, S_a = s_b\, S_b \tag{7}$$

The net expected return in case of success, on the other side, is given by

$$E(\varphi_{Sa}) = s_a\, S_a - s_a(1+r) \tag{8a}$$

$$E(\varphi_{Sb}) = s_b\, S_b - s_b(1+r) \tag{8b}$$

From (7), (8a) and (8b), there is an interest rate that equals the expected net return of both projects. This (critical) interest rate, is

$$1+r^* = \frac{s_a S_a - s_b S_b}{s_a - s_b} \tag{9}$$

It is important to notice that this critical interest rate is the rate that maximizes the return of the bank. Then, as the economy goes into a recession, (i) the probability of success of both projects is reduced proportionately or (ii) the probability of success of riskier projects is reduced more than proportionately. In the first case, the critical interest rate remains the same. In the second case, this interest rate will increase.

In order to solve this ambiguity, we can write the expected net return to the bank as:

$$E(\phi) = (1 + r)Bs_a + (1 + r)Bs_b + (1 - s_a)F + (1 - s_b)F - (1 + \rho)2B \tag{10}$$

Since we assumed that B = 1 and F = 0, the equation above can be rewritten as:

$$E(\phi) = (1 + r)Bs_a + (1 + r)Bs_b - (1 + \rho)2B \tag{10a}$$

Deriving (10a) with respect to r gives

$$dE(\phi)/dr = rs_a + (1 + r)ds_a/dr + rs_b + (1 + r)ds_b/dr = 0 \tag{11}$$

Solving (11) for r gives

$$r = \frac{\dfrac{ds_a}{dr} + \dfrac{ds_b}{dr}}{s_a + s_b - \dfrac{ds_a}{dr} - \dfrac{ds_b}{dr}} \tag{12}$$

Clearly, when s_a and s_b decrease, the rate of interest that maximizes the expected return to the bank has to increase, even if s_b is reduced proportionately – or more than proportionately – to s_a. Consequently, credit rationing increases.

4. Some critical remarks

The comparative statics of the model presented above features some important aspects concerning banking decision to advance credit. Firstly, a typical bank classifies the borrowers into groups according to the expected return of their projects. Secondly, the interest rate is charged concerning its impacts on the ability of the borrower to repay the loan. In S-W model, the adverse selection and adverse incentive effects embodied in the nonmonotonic relationship between the interest rate and expected return of the firm work as a screening device of the bank.

There are some critical aspects in the S-W solution, however. The main problem is related to the application of these results into a dynamic world. If a bank changes its expectations referring the return in case of success of a project *a* but does not change its expectations referring the mean return of the project - as given by equation 2 - it will imply that these more favorable expectations are ineluctable related to a lower probability of success. This result can be more clearly seen as follows. Suppose F equals zero, higher expected return in case of success and same expected (mean) return of a project *a* means that $s^1_a > s^2_a$ and $S^1_a < S^2_a$, where 1 and 2 refers to different periods. In spite of the fact that this hypothesis is an adequate way to deal with apparently identical projects in a stationary world, it implicitly states that higher revenues are ineluctable related to higher risk of default. However, as Keynes (1964, p. 135-7) stated, higher revenues (or quasi-rents) are usually related to more optimistic expectations. Thus, as expectations become more optimistic, the expected returns **and** the probabilities of success of the projects should increase simultaneously.

In other words, suppose a bank is deciding whether it charges a higher interest rate as a consequence of a higher demand for credit. If it expects a higher revenue in case of success, this can be properly related to a higher probability of success. Thus, a bank can charge a higher interest rate without increase its risk of default since the higher return on, say, project *a* is not related to any adverse selection or adverse incentive effect, notwithstanding the return of project *a* also increases[3].

The above considerations also show that the default of a project is defined in a quite mechanical way as one less the (subjectively) given probability of success; it has nothing to do with the ratio of financial commitment to expected revenue (in case of success)[4], the "sacrifice ratio" of the project. The probability of success of some project - and its risk of default - is (subjectively) determined in a quite independent way of the "sacrifice ratio". Formally, in terms of the S-W model, this ratio is given by the following equation:

$$\psi = \frac{B}{s_i S_i}, \qquad \text{for all } i. \tag{13}$$

Thus, the model implicitly states that the probability of success is the main (actually the only one) criterion the bank utilizes in order to evaluate the ability of the borrower to repay the loan. If we take two different projects, with two different expected returns and the same probability of success, a typical banker would say that these two projects have the same risk of default. However, it is possible to see that higher the "sacrifice ratio", higher the risk of default of the project[5]. At first glance, we can say that the probability of success of one's project is inversely related to this "sacrifice ratio".

Notice that the rationale suggested by the sacrifice ratio does not change dramatically if we consider the interest rate as a component of this ratio. The equation (13) is now given by

$$\psi = \frac{(1+r)B_i}{s_i S_i}, \qquad \text{for all } i. \tag{13a}$$

Notice that in order to equal the sacrifice ratio of both projects - a necessary condition to recover the indifference between projects with identical probability of success -, the bank should charge a higher interest rate on project *a*, a project whose probability of success is the same of project *b* but whose expected return in case of success is higher. In terms of S-W classification, project *a* would be a type 3 project and project *b* would be a type 2 or even type 1 project. As a consequence, the bank should charge a lower interest rate on project *a* than on project *b*. On the other hand, given the interest rate, project *b* is still more risky than project *a*.

It is also important to notice that the S-W solution depends crucially on the hypothesis that projects have identical expected returns. Given the expected (mean) return and the probability of success of the project, the probability of default is an mechanical outcome; to say that these probabilities are subjectively defined (*cf.* Stiglitz and Weiss, *ibid*., p. 395) does not change the nature of the model.

Success, then, can be more properly defined as the ability of the borrower to repay the loan, and this ability is a function of at least two variables: (i) the size of the expected revenue of the project; and (ii) the size of the ratio financial commitment to expected revenue, the sacrifice ratio. In other words, the lesser the "sacrifice ratio", the higher is the ability of the borrower to repay the loan.

Thus, in order to evaluate more properly the probability of success of some project it is more convenient to (subjectively) calculate what is the "sacrifice ratio" of each borrower. Consequently, projects must be classified according to this ratio. As a result, there is no ineluctable relationship between higher revenues of success and higher risk.

Since the expected revenue of the projects is actually a series of annuities termed quasi-rents, it is more convenient to substitute the revenue in case of success for quasi-rents in the equation of the sacrifice ratio. Notice that the probability of success disappears. Actually, it is substituted by the notion of state of confidence. Formally, if we suppose the state of confidence is equal to 1,

$$\xi = \frac{(1+r)\mathrm{B}}{\mathrm{Q}^{e}{}_{t}} \qquad \text{for all } t, \tag{14}$$

where ξ is the "sacrifice ratio" and $\mathrm{Q}^{e}{}_{i}$ is the expected quasi-rent for period i. It is clear that ξ will be higher if $\mathrm{Q}^{e}{}_{i}$ increases less than proportionately than B, and vice-versa.

If the financial commitments are equally distributed along the periods, equation (14) can be rewritten as follows:

$$\xi = \frac{(1+r)\mathrm{B}/n}{\mathrm{Q}^{e}_{t}}, \qquad \text{for all } t. \tag{15}$$

where n refers to the extent of the financial commitment[6]. Thus, from the bank's vintage point, the success is related to the ability of the borrower to repay the loan, and his/her ability is directly related to the relative size of the financial commitment. In other words, the bank realizes that the expected quasi-rents can change and this change can disable the borrower to fulfill his/her financial commitment. Clearly, the borrower will be more able to fulfill such commitments at each period lower is the financial commitment as a percentage of the expected quasi-rents. Thus, if we consider such possibility of fluctuation on the quasi-rents, equation (15) can be rewritten as

$$\xi = \frac{\mathrm{B}/n + r\mathrm{B}/n}{\mathrm{Q}^{e}_{t} - \delta^{2}_{\mathrm{Qt}}}, \qquad \text{for all } t. \tag{16}$$

where δ^2 refers to the expected variance of the quasi-rents.

The state of confidence the bank attaches to the expected quasi-rents is actually a mix of two variables[7]. The first one is a term, λ, applied to the expected variance of the expected quasi-rents in order to "inflate" such variance. When, for instance, the expectations of the bank become less optimistic, this term increases. As Minsky (*ibid*., p. 335) says, "[this term] is sufficiently great so that the subjective probability assigned to [$\mathrm{Q}^{e}{}_{t} < \mathrm{B}/n$] is acceptably small." The second one is a term, τ, that accounts for the margin of safety required by the lender in order to partially offset the lender's risk. This term is less than one for all t. Thus, less optimistic are the bank's expectations, lesser is τ. Now, equation (16) is written as

$$\xi = \frac{\mathrm{B}/n + r\mathrm{B}/n}{\tau(\mathrm{Q}^{e}_{t} - \lambda\delta^{2}_{\mathrm{Qt}})}, \qquad \text{for all } t,\ \tau < 1,\ \lambda > 1. \tag{17}$$

Another important aspect to be considered by the bank when advancing credit is the cost of liabilities. As demand for credit rises, the interest rate rises also[8]. As a consequence, "bank management will try to substitute liabilities with low-reserve absorption for those who consume more reserves until overt costs offset the differences in covert costs in the form of required reserves." (Minsky, *ibid*., p. 241-2). Thus, the advance of credit is costly to the bank for at least two reasons: first, there is a direct (overt) cost component, namely, the bank has to pay for funds. Typically, the bank "collect" funds through time deposits that cost ρ. On the other hand, every time a bank creates demand deposits against itself it has to keep reserves at central bank according to some reserve requirement ratio. These reserves represent effectively an opportunity (or covert) cost to the bank. Formally, we can represent the overt costs as

$$O_C = (1 + \rho)\, D_T, \tag{18}$$

where ρ refers to the interest rate paid on time deposits (D_T). The covert costs, on the other hand, are given by

$$C_C = q(1 + r)\, D_D, \tag{19}$$

where r is the rate of interest on the loan and q is the reserve requirement ratio on the demand deposits (D_D).

Given equations (18) and (19) we can say that, typically, the bank will try to maximize the following profit equation (*cf.* for instance, Santomero, 1984 and Dymski, 1988):

$$\pi^e = (1 + r)\sum_n B_i - (1 + \rho)\sum_n D_{T_i} - q(1 + r)\sum_n D_{D_i} \tag{20}$$

Notice, however, that both ρ and D_D are functions of r. The interest rate paid on time deposits typically "follows" the interest rate charged on loans. Clearly, ρ is lower than r. We can assume that $\rho = \gamma r$, where $0 < \gamma < 1$. On the other hand, demand deposits are sensitive to movements on interest rate paid on time deposits. Thus, higher ρ, higher is the percentage of demand depositors that transfer their funds to time deposits. Given all this assumptions, equation (20) can be rewritten as

$$\pi^e = (1 + r)\sum_n B_i - [1 + \rho(r)]\sum_n D_{T_i}(\rho) - q(1 + r)\sum_n D_{D_i}(r) \tag{21}$$

The main problem with equation (21) is the determination of the volume of credit supply, $\sum B_i$. We can assume that the balance sheet of a typical bank equals[9]

$$\sum_n B_i = (1 - q)\sum_n D_{D_i}(r) + \sum_n D_{T_i}(\rho) \tag{22}$$

Thus, (21) can now be rewritten as

$$\pi^e = (1 + r)\left[(1 - q)\sum_n D_{D_i}(r) + \sum_n D_{T_i}(\rho)\right] - [1 + \rho(r)]\sum_n D_{T_i}(\rho) - q(1 + r)\sum_n D_{D_i}(r) \tag{23}$$

Solving (23) to r gives

$$r = \frac{\left\{(1-2q)\sum\limits_{n} \mathrm{D}_{\mathrm{D}_i}(r) + \left[1-\frac{\mathrm{d}\rho(r)}{\mathrm{d}r}\right]\sum\limits_{n} \mathrm{D}_{\mathrm{T}_i}(\rho) + \left[1+\rho(r)\right].\frac{\mathrm{dD}_{\mathrm{T}_i}(\rho)}{\mathrm{d}r}\right\}}{\frac{\mathrm{dD}_{\mathrm{D}_i}(r)}{\mathrm{d}r}\left(1-2q\right)+\frac{\mathrm{dD}_{\mathrm{T}_i}(\rho)}{\mathrm{d}r}} - 1 \qquad (24)$$

Since r is determined according to (24), we can now turn to the credit rationing. Given the optimal interest rate, and according to the sacrifice ratio a bank defines for a borrower or a group of borrowers, it will offer an amount of credit supply that could not fit well the demand of the borrower. In other words, given the mentioned parameters, the bank decision could (and probably will) lead to a credit rationing to a group of borrowers. It can be seen more formally. Solving equation (17) for B gives

$$\mathrm{B} = \frac{n\xi\tau(\mathrm{Q}_{\mathrm{t}}^{\mathrm{e}} - \lambda\delta_{\mathrm{Qt}}^{2})}{(1+r)} \qquad (25)$$

Indexing (25) for individual borrowers (or group of borrowers) gives

$$\mathrm{B}_i = \frac{n\xi_i\tau_i(\mathrm{Q}_{\mathrm{t_i}}^{\mathrm{e}} - \lambda_i\delta_{i\,\mathrm{Qt_i}}^{2})}{(1+r)} \qquad (26)$$

Thus, given ξ_i - and, of course, the others parameters of equation (26) -, the banking decision concerning r could imply that the amount of credit supplied is less than the amount demand by the borrowers inside a group. Notice that we are implicitly assuming the hypothesis of indivisibility of the capital requirement of the project.

Actually, the model suggests a criteria relating to the bank's choice. Typically, a bank will set different values for ξ, τ, λ, δ^2 and Q_i according to its expectations concerning the expected quasi-rents of the project and according to its characterization of the borrowers. According to the values a bank sets to these variables, it will lead to more or less credit rationing. Thus, given the interest rate - and the amount of credit supply a bank will advance - more or less borrowers will be credit rationed more or less optimistic is the bank. The table below summarizes our arguments.

Expectations	ξ	τ	λ	δ^2	$\mathrm{Q}^{\mathrm{e}}_i$	B_i
More Optimistic	Higher	Increases	Decreases	Decreases	Increases	Higher
More Pessimistic	Lower	Decreases	Increases	Increases	Decreases	Lower

It is worth noting that, despite the credit rationing, a typical bank does not perform a role of "automatic stabilizer" (*cf.* Hermann, 1997, p. 9) as in the S-W model. In other words, if we assume that a higher demand for credit is associated to the beginning of the boom - since it is implied by higher demand for investment - it is plausible to assume that the bankers share the expectations of the entrepreneurs. As a consequence, the bank should increase the credit supply. In S-W model, differently, the bank will be the only obstacle to the implementation of the higher investment demand.

This result can be more formally defined. As banks become more optimistic, they will actively seek for funds. This will lead to a rise in $\rho(r)$. Thus, the optimal interest rate will rise. Since, as shown in the above table, ξ becomes higher, τ and $Q^e{}_i$ increase, λ and δ^2 decrease, B_i will increase also. Accordingly, the credit supply increases altogether and the credit rationing will be lower.

The model also shows the increase of financial fragility when banks are more willing to advance credit. As noted, the decline of the margin of safety, combined with a lower expected variance of the quasi-rents and a higher sacrifice ratio imply a higher risk in advancing credit. It means that a bank is more willing to "accept" a more fragile financial structure on the borrower's side since it believes that the borrower is more able to fulfil his/her financial commitments (*cf.* Minsky, *ibid.*). Such movement towards financial fragility accounts for the adverse selection and adverse incentive effects (*cf.* Hermann, *idem*, p. 11). In spite of the fact that more optimistic expectations of the banks lead to an increase of the financial fragility of the economy, banks are not able to perceive this movement; that is, they do not relate high interest rate to high risk of default[10]. As a consequence, they cannot behave as automatic stabilizers that are capable to prevent crashes.

5. Conclusion

S-W model of banking firm behavior does not adequately deal with some important questions concerning credit advancing. When advancing credit, a typical bank tries to evaluate the ability of the borrower to repay the loan. It knows that the borrower will succeed if the expected quasi-rents of his/her project come true. These quasi-rents, on the other hand, are based on scenarios of the banking firm (*cf.* Minsky, 1982, p. 19). Accordingly, the observable quasi-rents can be different from the expected ones, *i.e.* they can change. Thus, the bank realizes that the referred ability to repay the loan will be higher if the financial commitments do not represent a significative percentage of these quasi-rents. Success, then, is related to this percentage we termed "sacrifice ratio".

All these questions are not treated adequately in S-W model. Another important aspect of the bank behavior is related to its willingness to advance credit as its expectations concerning the quasi-rents of the projects become more optimistic. If almost all agents share these expectations, it would be translated in a investment demand push. Clearly, it would lead to a higher supply in credit market[11]. As noted, in S-W model this would not occur and banks would act as "automatic stabilizers".

The model presented in section 4 tries to deal with all these questions. It shows not only the importance of banks expectations in determining the credit supply but also tries to stipulate some "choice criteria" to banking decisions. More importantly, it shows that not only credit supply increases as banks become more optimistic but the financial fragility increases also.

This rationale arises another important question concerning the definition of credit rationing. The most important feature of this definition is the notion of **choice** of the banking firm. On the macroeconomic side, some authors (e.g. Keynes, *ibid.*, Minsky, *ibid.*) have shown that the investment decision is taken **after** the arrangements of finance; that is, there is no effectively **quantitative** credit rationing. The bank in fact changes the terms under which credit is supplied. However, as stated in section 4, as banks become more optimistic they will actively seek for funds in order to serve the eligible borrower's demand. As a consequence, the rate of interest charged will be higher and the impact of the bank's revaluation of the ability of repayment of the borrower will be crucial to determine the increase in B. Thus, it can "depress" the investment demand since at new interest rate some investment projects are not profitable anymore[12]. That is precisely the notion of credit rationing of our model.

6. References

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[1] It is important to notice that, in this case, the expected gross return to the bank equals the expected net return since there is no explicit cost of loanable funds. In the next section, we extend the model in order to incorporate the cost of loanable funds.

[2] As Jaffee and Stiglitz (*ibid.*, p. 860) notice: "Reduced credit availability has its first impact on the marginal group: more of these borrowers become rationed (...). Moreover, a sufficiently large reduction in credit availability will be reflected as a change in the marginal group. In this case, the interest rate will be adjusted, the old marginal group will be totally excluded from loans, and the new marginal group will be partially excluded from loans."

[3] Actually, the hypothesis of same expected return to projects into a same group is adequate only to stationary situations, in spite of the fact that it is possible to talk about nonmonotonic relationship between interest rate and expected return of the banking firm in situations where the expected return of

the apparently identical projects changes. This is near the case of distinguished borrowers analysed in section 3 above.

[4]Even if we consider that there is some relationship between the amount borrowed and the expected revenue (in case of success) in the S-W model, actually the subjective probability of success is the main determinant of the borrower's ability to repay the loan. As will be shown, this result depends crucially on the hypothesis of immutable expected (mean) return of the project.

[5]Consider, for instance, projects *a* and *b*. If S_a = \$1,000, s_a = 0.5 and B_a = \$100, and S_b = \$700, s_b = 0.5 and B_b = \$80, and the unsuccessful revenue is zero, the sacrifice ratio for project *a* equals ξ_a = \$100/(0.5 x \$1,000) = 0.2 and for project *b* equals ξ_b = \$80/(0.5 x \$700) = 0.23. Thus, according to this risk indicator, project *b* is more risky than project *a*, although according to S-W model project *a* and project *b* have the same risk of default.

[6]This is not the only possible financial structure, although it is the simplest one. We can write different "ratios of sacrifice" for different amortization schemes. For instance, the first instalment of the loan can be lower (higher) than the last one.

[7]This rationale is based on Minsky (1986, appendix A).

[8]Notice that, even in S-W model, interest rate rises as a consequence of demand push, even though the interest rate that maximizes bank's profit does not necessarily equalizes demand to supply of credit.

[9]In order to simplify the arguments, we are assuming that loans and reserves are the only components of the asset side of our banking firm, and its assets position is financed solely by demand deposits and time deposits. Equity, therefore, equals zero.

[10]Actually, a bank can make "fine tunings" in the values of the parameters of (26) in order to deal more adequately with the effects of higher interest rates on some borrower of group of borrowers.

[11]It can even be translated by a less sloped curve of supply of credit.

[12]Of course, it will be ultimately determined by the expectations of the entrepreneurs.