CREDIT MARKETS WITH ASYMMETRIC INFORMATION: AN OVERVIEW ON THE RATIONING ISSUE (*)

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Sumário

Após a formulação da doutrina de *availability* de crédito (Roosa, 1951), o interesse pelo fenómeno «racionamento de crédito» manteve-se constante. A recente literatura, quase sem excepção, utiliza a hipótese de informação privada. Jaffee e Russel (1976) exploram o incentivo que um devedor «desonesto» tem em não pagar a dívida numa economia onde o custo de falência é (exogenamente) fixo; quanto maior for o crédito obtido, maior será, então, o incentivo em declarar a falência. O mercado de crédito é concorrencial, donde os contratos de crédito no equlíbrio têm lucro esperado nulo. Devido à informação incompleta e ao incentivo que o devedor desonesto tem em fazer-se passar por honesto, e por os bancos concorrerem pelos devedores, um equilíbrio separado não se obtém; portanto, somente um contrato de crédito é oferecido pelos credores no equilíbrio. Neste, os devedores desonestos desejariam um volume de crédito maior do que o do equilíbrio, sendo portanto racionados (racionamento do tipo I, segundo a terminologia de Keeton, 1979).

Stiglitz e Weiss (1981) exploram também a selecção adversa numa economia onde os bancos concorrem pelos depositantes: os bancos com maior rentabilidade conseguem pagar melhor os seus depositantes ganhando mercado. Os devedores (firmas) diferem na qualidade, em termos da variância da distribuição da rentabilidade, dos projectos de investimento que possuem; todos os projectos têm a mesma rentabilidade média ou esperada e necessitam do mesmo montante de capital. Em caso de falência, as firmas são protegidas pela cláusula (estatuto) de responsabilidade limitada, perdendo a hipoteca que tenham depositada no banco — Stiglitz e Weiss assumem, na primeira parte do artigo, uma hipoteca de valor nulo; como consequência , o lucro esperado da firma é maior quanto maior for o risco (i. e., maior variância) do projecto que ela tiver. Um aumento da taxa de juro incrementa o lucro esperado do banco dada a carteira de créditos; a este efeito «rendimento», contudo, opõe-se a selecção adversa, uma deterioração na qualidade média da carteira de créditos resultante do facto de a transferência de rendimento do devedor para o credor, induzida pelo aumento da taxa de juro, fazer o lucro esperado das firmas de menor risco tornar-se nulo antes do das firmas de maior risco. Donde

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a curva de oferta de crédito não é monótona; quando a curva de procura de crédito estiver à direita do ponto de inflexão da curva de oferta — um caso onde o crédito (agregado) é escasso —, um aumento da taxa de juro para além do ponto de inflexão nunca pode ocorrer, segundo Stilitz e Weiss, porque: *(i)* os bancos suboptizam, e num mercado concorrencial perdem depositantes e desaparecem; *(ii)* a firma que, não obtendo crédito, oferece uma remuneração mais alta ao potencial banco não consegue induzir um aumento na oferta de crédito, uma vez que a firma só pode ser uma com um projecto de maior risco associado com uma rentabilidade negativa esperada para o credor. Em equilíbrio, os bancos oferecem contratos de crédito num montante inferior ao da procura agregada; as firmas são racionadas estocasticamente.

O fenómeno da selecção adversa deve-se à ausência de *signalling* por parte das firmas sobre a sua qualidade — o que é pouco razoável — ou de *screening* por parte dos bancos; os comentadores tem-se concentrado sobre este último aspecto (e. g., Bester, 1985), nomeadamente na utilização da hipoteca como uma variável estratégica para se obter um equilíbrio separado. Recentemente, Cho e Kreps (1986) formalizaram o contrato de crédito como um *signalling game,* adoptando na solução do jogo os critérios de estabilidade avançados por Kohlberg e Mertens, obtendo separação; Hellwig (1986b), usando o mesmo conceito de equilíbrio, mas com uma diferente ordem do jogo, obtém racionamento.

Beneficiando do trabalho pioneiro de Townsend (1979), Gale e Hellwig (1985) e Williamson (1984) estudaram a natureza da estrutura financeira numa economia com informação privada, mas que é observável se se incorrer num custo exogenamente dado. Em ambos os trabalhos, a estrutura financeira endógena da economia é formada somente por crédito (e capital próprio, se os empreendedores tiverem recursos próprios); o contrato de crédito é qualificado de *standard* — um contrato óptimo e *incentive compatible,* onde a firma paga juros quando o projecto de investimento for um sucesso e, no caso contrário, com confiscação do produto residual deduzido do custo de observação pelo credor. Em Boyd e Prescott (1986), Williamson (1985) e Diamond (1984), a função de intermediação aparece endogenamente — i. e., bancos como uma entidade própria e não como um somatório dos créditos na economia —, devido à necessidade de eliminar o fenómeno de *free rider* quando os investimentos são financiados por mais de um credor (Diamond) ou para garantir um rendimento certo para os depositantes (Boyd e Prescott e Williamson) — uma grande coligação de depositantes consegue financiar um grande número de investimentos cancelando, no limite, o risco da carteira. Voltando à contribuição de Gale e Hellwig, a existência da falência com a possibilidade de o credor confiscar o valor residual da firma tem uma interpretação económica importante; se os capitalistas financiarem o investimento comprando acções, o empreendedor, recionalmente, declarará sempre que o investimento não foi produtivo, pagando o mínimo possível (0) aos accionistas. No caso do contrato de crédito, o não cumprimento dos termos do contrato por parte da firma permite

ao credor declarar o primeiro em falta e confiscar o produto do empreendimento para si suportando o custo de observação; como este não é pequeno, não é racional observar sempre o rendimento do empreendimento — de onde suboptimalidade das acções —, o credor estabelecerá um limiar (o ponto de falência) abaixo do qual o credor verificará o rendimento do projecto incorrendo no custo de inspecção. O referido limiar pode ser ajustado por forma a obter um lucro esperado não negativo para o credor. A economia beneficia porque a oferta de fundos será positiva, aumentando o investimento, e haverá um facto relevante, uma partilha parcial de risco entre os diversos agentes devido à possibilidade de falência. Gale e Hellwig mostram que numa economia com uma função de produção côncava o nível de investimento associado ao contrato de crédito *standard* é inferior ao nível quando o custo de observação é nulo (i. e., o caso da informação simétrica); esta diferença é interpretada, como racionamento de crédito. Num contexto com a mesma tecnologia produtiva, mas com informação simétrica, obteve-se racionamento de crédito entre o nível de crédito que o banco está disposto a oferecer e aquele que a empresa desejaria dado o nível da taxa de juro (Chau, 1987); o racionamento é o resultado do conflito inerente no estatuto de responsabilidade limitada, nomeadamente entre a necessidade de induzir a oferta de crédito (lucros esperados não negativos para os bancos) e o estímulo que dá às empresas em escolherem empreendimentos com (maior) risco.

Williamson (1984) mostra que, devido ao custo de observação, um aumento da taxa de juro tem dois efeitos opostos; um positivo para o credor, porque o rendimento esperado aumenta, mas que é contrariado pelo aumento da probabilidade de falência — porque os créditos são mais onerosos para os devedores —, incrementando o custo esperado de observação. Quando a taxa de juro for suficientemente alta, associada a uma probabilidade de falência igual a 1, o lucro esperado marginal do credor é negativo por o incremento de receitas ser 0 e o custo marginal de observar o projecto é positivo; por continuidade da função de lucro esperado do credor tem-se um ponto óptimo (interior) no problema de maximização de lucro do credor. Neste ponto, pode existir ou não racionamento. No caso positivo, variações da taxa de juro são inoperativas, mas variações na oferta de liquidez na economia são eficazes na redução do racionamento sem afectar a taxa de juro de equilíbrio — um resultado excepcional, confirmando o canal de liquidez subjacente na doutrina de *availability* do crédito.

Recentes trabalhos avançam em direcções bastante interessantes, tais como a possibilidade de sobre ou subinvestimento (de Meza e Webb, 1987, e Milde e Riley, 1988), sobre o colapso do mercado de crédito (Mankiew, 1986, e Bernanke e Gertler, 1986 e 1987) e sobre o mecanismo de transmissão da política monetária (Keeton, 1979, e Blinder e Stiglitz, 1983). Estes trabalhos, no entanto, merecem um tratamento separado.

1 — Introduction

Research over the past two decades suggests that the credit market has some unique features, in particular the possibility of equilibrium rationing, and of over or under-investment, etc. Much of the current research was inspired by the Stiglitz and Weiss (1981) paper; Jaffee and Russel (1976) is the first article studying the credit market under the asymmetric information assumption. Almost all contributions on credit rationing use this assumption due to the progress made in the 70's in the research on signalling, insurance markets, and optimal risk-sharing contracts. Stiglitz in his review paper (1987) focuses on the (wider) question of market mechanism under asymmetric information; Akerlof's (1970) pathbreaking study is responsible for the subsequent interest in the asymmetric information assumption.

The assumption of private information has led theorists to study new concepts of equilibrium and to question the market mechanism under the traditional summetric or perfect information case. Although there is a variety of possibilities of introducing the asymmetric information assumption (e. g., on the realization of the state of the world, or the quality of a good), economists have concentrated on some important cases. Accordingly, the structure of this review is dictated by the relevant literature on credit markets; it will focus, first, on theoretical models and, then, on the credit literature.

Under the assumption of private information, interest centers on its implications for the market mechanism (do price adjustments eliminate the excess supply?) and equilibrium (does it exist?). If such effects are non-trivial, then one studies the introduction of new elements in the model (institutions is the term usually used) to solve or to dampen the effects of private information. Thus advertising, historical records, collateral, etc., constitute a response to the presence of asymmetric information. The models dealing with static economies with asymmetric information can be distinguished broadly as:

— Signalling;
— Adverse selection;
— Costly observation;
— Moral hazard.

Models focusing on the possibility of, or mechanisms by which, informed traders signal their intrinsic quality, use the concept of informational equilibrium (see Riley, 1979). In this equilibrium, asymmetric information is overcome and the market has a price for each quality of the goods; thus, heterogeneous traders or goods have different prices or price-signal. This literature on information transmission mechanisms is known by signalling. When no signalling is feasible and the market price reflects the average quality, then there is an adverse selection phenomena; it is also known as self-selection mechanism which has been dramatically illustrated in Akerlof's «lemons» example. In the insurance market, the absence of signalling generates a pooling equilibrium

wherein good risks subsidize (pay more than the actuarily fair premium) bad risks (see Rothschild and Stiglitz, 1976). This equilibrium can be characterized by rationing (1) as an increase of the premium may be counterproductive; it may be that a rise in the premium leads good risks to drop out of the insurance market while the bad risks remain; consequently, the insurance firm suffers an expected loss. In the informational equilibrium, the private information disappears (due to signalling or screening), but in the adverse selection case, private information remains.

Townsend (1979) studies the incentive compatible contract in an environment with costly verification of private information; in other words, the uninformed party can verify with certainty the true information but a cost. Under deterministic rules of verification (e. g., auditing a firm when and only when it defaults), he showes that the optimal contract is an uncontingent contract for some states of the world (exactly the ones where verification is not carried out) with confiscation otherwise.

Another group explores imperfect information wich cannot be verified with certainty (or perfectly); such models are described as «hidden action» in contrast to the above models of «hidden information». The informed agent has an incentive not to reveal the action s/he took because s/he is not fully rewarded by doing so and because it is not perfectly observable by the unninformed agent. Since the action affects the principal's (the uninformed agent) utility or profits, monitoring the informed agent's actions or providing incentives to the latter such that the chosen action is the one the principal preferes are used to overcome or to reduce the moral hazard problem. This problem is usually studied in the framework of the principal-agent model, in which the agent chooses an action wich affects the (expected) productivity of a project or production and, due to a noise, it is not observable by the principal with certainty. The noise constitutes a risk to the agent as it affects her/his productivity. The object is to devise a rule for sharing the surplus or risk in the relationship. The economy with moral hazard, in turn, can be plagued by «hidden information» as in Arnott and Stiglitz (1982) insurance market model where the insured's effort in avoiding accidents depends on the overall coverage s/he has; additional purchases of insurance can make previous contracts become unprofitable as the level of care decreases. In the extreme case, if the insurance companies do not share information concerning their clients, the insured is tempted to take full coverage and make no effort.

2 — Signalling

In a market where buyers are less well-informed about product quality then sellers, prices reflect average quality. Therefore, agents with inherent quality

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(1) An excess demand for insurance at the equilibrium premium-benefit ratio.

(low-risk borrowers, higly productive agents, etc.) are interested to signal their type or quality so that they can fetch a higher price. Can apparently identical but intrinsically different agents be sorted out? Spence (1974) shows how a mechanism can be constructed to sort different type of agents; in Spence's signalling environment, a productive agent is assumed to have a lower cost in acquiring education than a less productive one. Then by providing labour contracts with the wage offer as a function of the level of (acquired) education, employers can sort who is more or less productive. Education constitutes the selection mechanism in worker's point of view, or screening device in firm's point of view. In equilibrium, the employers know the true type of their workers; signalling by productive agents has achieved a transmission of valuable information to worse-informed agents. Hence the wage schedule is called «informationally consistent». But Riley (1979) shows that the Spences equilibrium is not sustainable as traders, after learning the time types, can offer a new (wage) contract at the lower end of agents' quality that leaves these agents as well off as in he original contract and increases employer's profits. In a general equilibrium, competitive framework, Prescott and Townsend (1981) show that the signalling environment does not have a competitive equilibrium, or, if it exists, there is no signalling.

Asymmetric information, however, exacts a cost in the from of the loss in utility the productive agent incurs in obtaining education wich has no other use but to signal the agent's quality; in fact the signalling equilibrium is not even a Pareto-constrained optima as there are taxes os subsidies to generate the same equilibrium without the need to invest in signals (2) by the informed agents. Thus, in Prescott and Townsend (1981), the Pareto optima in the signalling environment does note involve a complet separation of types (i. e., there is no signalling). This result supports the claim that the information externality imposes a wedge between the private and the social investment in the signal.

In Rothschild and Stiglitz (1976) and Wilson (1977), the quantity of insurance or coverage an agent demands can be used by firms to their advantage; as high risk agents demand greater coverage, the insurance company can offer high coverage contracts at higher premium. But an actuarially fair full-insurance contract cannot be offered to low-risk agents because it also attracts high-risk agents and hence the firm makes an expected loss from such contracts. Under free entry, the set of contracts offered by firms in Rothschild and Stiglitz's insurance model is such that *(i)* no contracts make negative expected profits, and *(ii)* no other potential contract would make a positive profit if offered; Rothschild and Stiglitz show that if the gap between high and low risk is sufficiently large then there is no Cournot-Nash equilibrium. Put in another way, if a firm assumes that the contract its competitors offer do not depend on its own actions, then

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(2) Suppose that productive agents make calculation with pencil and paper only but less productive agents need calculators. A tax on calculators can be enough to separate the heterogeneous agents.

for some contracts that separate the existing risks satisfying *(i)* above, there is always another contract that violates *(ii)*; in particular, a separating equilibrium can be undone as a new pooling contract can be introduced in the market which is preferred by all agents and it is profitable to do so. In turn, given a pooling contract that breaks even, one can construct another contract wich is preferred by the best risk and violates *(ii)*; i. e., along the pooling zero-profit line (the market odds line) the marginal rates of substitution differ over risks and hence there is a contract preferred by the low risk giving positive profits when only low risk buy it (see Hirshleifer and Riley, 1979, pp. 1406-1408); but then the pooling contract does no longer break even as there are only high risk. The non-existence result is confirmed in a general equilibrium, competitive framework by Prescott and Townsend (1981). However, Hellwig (1986b) argues that pooling can be a perfect equilibrium.

The important point made by this self-selection literature is that better informed traders have an interest to signal their quality through some variables other than price (education in Spence model, and quantity of insurance in Rothschild and Stiglitz). A second point is that a pooling equilibrium, in wich the price reflects the average quality or risk, is more likely than a separating equilibrium (3). In the pooling equilibrium, uninformed traders continue to be so.

3 — Adverse selection

In the absence of signalling, the market price is an average of the existing quality or risk; this lack of separation of heterogeneous agents (or goods) has an important consequence on the market mechanism. As illustrated in Akerlof's «lemon» example (1970), in the absence of signalling, the market mechanism can be inoperative; at a given price, sellers of low-quality goods are attracted to the market depressing further the price (as the average quality in the market dwindles) wich makes the market unattractive to sellers of high-quality goods.

Consequently, the price of a market with undistinguishable heterogeneous traders reflects and determines the average quality of the market. In insurance markets, an increase in the premium makes the low risk to withdraw from the insurance pool increasing the share of high risk in it; the average riskness of the pool deteriorates. Self-selection is a problem as the high-risk or poor quality will mimic the good risk or high quality's behaviour since they benefit from lower premium (than the actuarially fair one) or higher prices. Thus, it is not in the interest of the high risk to reveal himself as such; to do so leads the insurer or lender to impose higher costs or even to entirely deny coverage or loans.

In Wilson (1980), which is a reexamination of Akerlof's paper, the demand curve is not necessarily downward sloping when the price is an indicator of

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(3) This statement is not true when the proportion of low risk is high. Pooling risks as a constrained Pareto optimal outcome can be rationalised as a Bertrand competition (see Hellwig, 1986b).

quality; as the price rises, sellers of high-quality goods are attracted to the market and so the average quality increases. Wilson shows that there can be multiple equilibria in a market where the price reflects the average quality of goods. Equilibrium is, then, a distribution of prices rather than a single price and excess demand can prevail at some of those prices.

4 — Costly observation

Unlike the preceding models dealing with market equilibrium, Townsend (1979) studies the characteristics of a bilateral trade contract when the private information can be observed with certainty at some cost by the uninformed party. Since it is costly to do so, the uninformed agent will not always verify the private information; then, the uninformed agent's payoff depends upon an annoucement made by the informed party for the states of nature where no verification occurs. Townsend assumes that the uninformed party's payoff increases with the announcement made by the informed and, when verification occurs, all the informed agent's payoff is transferred to the uninformed party. As observation entails a cost, the incentive problems created by informational asymmetries make contingent contracts (i. e., based on the actual occurence of the state of the world) uncontingent in reality as such contracts cannot be enforced for states of the world which are not publicly observed.

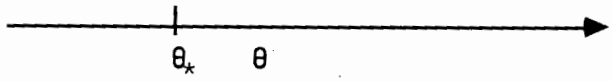

FIGURE 1

If θ, a random variable, is privately observed, and θ^* is the trigger (verification) point whereby for an announcement ($\hat{\theta}$) of the informed agent which is lower than θ^* the uninformed agent will verify the actual θ (see fig. 1), then for a θ greater than θ^*, the informed agent has no incentive to announce an $\hat{\theta}$ lower than θ^*, as the uninformed party will verify, the cheating is unraveled and, worse, all the production goes to the uninformed party; in other words, since the uninformed agent observes the actual θ when $\hat{\theta} < \theta^*$, there is no gain for the informed agent in pretending that $\theta < \theta^*$, when it is not. When θ is lower than the trigger point, the informed party has also no incentive to declare a high $\hat{\theta}$ (i. e., $\hat{\theta} > \theta$ as the payoff of the uninformed agent will be greater than the one associated with the true value of θ), and hence the informe agent will thruthfully reveal θ ($\hat{\theta} = \theta$). Thus, when $\theta < \theta^*$, the contract is incentive compatible, i. e., the informed agent has no incentive to lie. For any $\theta \geqslant \theta^*$, however, the informed agent is better off by announcing a $\hat{\theta} = \theta^*$, as no verification will be made and s/he can keep the surplus to himself; that is, because private information is costly to observe, the terms of the bilateral contract cannot

depend on θ for $\theta > \theta^*$. In other words, the incentive compatible contract is a uncontigent or constant payoff contract in case of no verification. Townsend shows that *(i)* the verification set is not empty and depends on the verification cost, and *(ii)* the incentive compatible contract is an optimal contract. The last property is lost, however, when the verification rule is not deterministic (e. g., random auditing). Weskamp (1987) shows that the optimal verification rule is no longer so when there is more than one good (investment involving joint production); for any possible inspection rule, given observation costs, one can find another rule that weakly (Pareto) dominates the former (4).

5 — Moral hazard

The models surveyed above focus on the (lack of) transmission of information from the informed to the uninformed agent. Thus, if there is signalling the uninformed agent becomes perfectly informed, i. e., private information is completely revealed; in the case of costly observation, the same is true. The uninformed agent is engaged in screening or verifying the true quality of a good or the true type of an agent while the informed agent sends signals or mimics the behaviour of lower-risk agents.

The case of all- or-nothing transmission of information (completely and perfectly revealed or no revealation at all) seems to be contriving. When information is imperfect, or when the transmission of information is incomplete, the uninformed agent cannot verify the true realisation of the state or the true type of an agent. If the informed agent does not fully benefit from his unobserved action, he has an incentive to exploit such imperfection in information; e. g., homes are not locked properly because they are insured against theft, heating is never turn-of when it is not needed because it is included in the rent, etc. The last example does not have imperfect information but an incentive effect exists. In such cases, the uninformed agent (the principal) may prefer to engage into monitoring the activities of the informed agent, or to design an incentive mechanism to reduce the incentives the informed party has in choosing his unobserved actions (locking doors, windows, etc.). When complete monitoring is feasible and has low costs (e. g., metering the heat used) then no incentive effects arise; in general, however, full observation of actions is either unfeasible or expensive.

The incentive problem does not depend solely on imperfect information, as the above heating example illustrates. When the interest of the parties of a contract cannot be reconciled by changing the terms of trade an incentive

(4) Since the verification rule depends on the productivity of both goods, it is always possible to outweigh the cost of inspection dictated by the bad performance of one good by the decrease in the need of inspection dictated by the other.

problem exists. The difficulty for the price to solve the incentive problem is due to a fundamental non-convexity of preferences. For example, in an insurance contract, when the consumer buys more insurance s/he spends less effort to prevent accidents; at a given level of effort, the marginal willingness to pay for more insurance is usually assumed to be decreasing in the amount of insurance the agent already has. But the decrease in effort due to the increase in the quantity of insurance purchased increases the probability of an accident; hence the willingness to pay for additional insurance increases. When this effect outweighs the above one there is a moral hazard or incentive problem.

The insurance literature on moral hazard has emphasized, however, on the imperfect information aspect. Under this assumption, the optimal risk-sharing contract can be affected by monitoring the unobservable actions. With full observation, the optimal contract is the one in wich the risk-neutral party takes up all the existing risk (Shavell, 1979b), proposition 4); in general, the first-best contract can always be achieved by a forcing contract that penalizes heavily any dysfunctional behaviour wich is detected. The second-best contract due to imperfect information can be arbitrarily close to the first-best contract if the uninformed party can detect cheating or shirking of the informed party with positive probability (Harris and Raviv, 1979). Holmström (1978) shows that any additional information about the informed party actions, however imperfect, can be used to achieve a contract which is close to the first-best contract. Shavell (1979b) has a similar result: if the informed agent is risk averse, the optimal risk-sharing contract depends on any information the uninformed party has about the informed party's actions.

The moral hazard problem in the insurance market is compounded when the insurer does not observe the amount of insurance an insured already has as the incentive effects are outside of the insurance company's control (Arnott and Stiglitz, 1982, 1986, and Hellwig, 1983). Because the level of care or effort in avoiding accident depends on the insurance the agent has, the possibility an agent has to contract with more than one company affects the profitability of the contracts the insured already has. The failure of each insurance company to internalise the above externality of a decreased incentive for the insured to take up effort leads to rationing of the total insurance available in the market (Hellwig, 1983, proposition 4.1 with no observability, and Arnott and Stiglitz, 1986, for the observability case); that is, the total amount of insurance available in the market is such that insured agents provide some effort which allows the existing insurance contracts to break even or to have positive profits. When the total amount of insurance an agent buys is observable, the contract an insurance company offers when it is required to break even (i. e., to «stand alone») has to be such that the premium-benefit ratio induces a proper care or effort to reduce the probability of an accident. When additional insurance is available, however, there is a problem as it affects the profitability

of all existing contracts and so these contracts will be withdrawn from the market; with less insurance, agents are worse off and will increase their effort. But when every agent is required to deal with only one insurance company (i. e., the exclusivity condition in Arnott and Stiglitz), any such externality is washed away and the company can offer contracts with cross-subsidization such that the agent prefers the equilibrium with observability and exclusivity (Hellwig, 1983, proposition 5.1 shows that it is a sub-game perfect equilibrium). When the decision to reveal customers' identity and coverage is integrated in the firm's strategy, some companies will not supply this information while, at least, two will publicize all the relevant information. Because the companies that offer secret supplementary contracts make a profit only if the other companies continue to offer the public contracts, they have an incentive to keep their customers purchases and identity secret. This leads again to the case of exclusivity such that and insurance company can cross-subsidize the different contracts to the same individual.

If communication among insurance companies is ruled out, Hellwig (1983) shows that an equilibrium with rationing exists. This equilibrium can have positive profits but no new firm enters as there are standby contracts that make any entry unprofitable; such standby contracts, however, are not actually traded in equilibrium. Even though the equilibrium in such markets depend on special assumptions (e. g., exclusivity, standby contracts), the basic observation that a market providing some insurance is preferred to the one with none of it, that is, rationing is preferred to zero insurance, seriously limits the proposition of non-existence of equilibrium when the insured's purchases are not publicly observable and when there is no communication among insurance firms.

6 — Credit rationing literature

When the bankruptcy probability is not nil, it is known that competition among lenders implies that loans with different bankruptcy probability should be priced accordingly (e. g., in Jaffee and Russel, 1976); in other words, since loans with different bankruptcy probabilities are different (i. e., heterogeneous) goods ([5]) there should be one price for each type of loans, where the type refers to the bankruptcy probability. Nonlinear pricing, however, cannot be used in some interesting cases; e. g., in the Stiglitz and Weiss (1981) model, the riskiness of a loan is privately observed, and so lenders, in fact, face publicly indistinguishable potential borrowers; similarly, in a principal-agent model with unobservable (or imperfectly observable) effort, the credit contract cannot be contingent on the riskiness of the project as it depends on the agent's (the borrower's) unobservable effort.

([5]) This is the approach taken by Keeton (1979).

Early models of credit rationing take the size of the loan as a signal of the quality or riskiness of a borrower. For example, when the bankruptcy costs are given, the default probability increases with the size of the loan. If the lender cannot charge different interest rates to different borrowers, then borrowers requesting larger sums are «rationed» because such loans are associated with negative expected return (profits) for the lender. Therefore rationing occurs not as a result of asymmetric information, but because of an exogenous constraint (e. g., interest rate ceiling regulations, law, or custom) forbidding lenders to charge different rates of interest for different clients, i. e., because the number of contracts available in the market is restricted exogenously. An upward sloping supply of loans schedule reflects the increasing risk of default as the loan size increases.

Jaffee and Russel (1976) incorporate asymmetric information in the credit market with the aim of obtaining credit rationing, which is defined as a situation where a borrower receives less credit than is demanded; their model is an application of the Rothschild and Stiglitz (1976) insurance model. Agents live two periods and use the capital market to smooth their consumption stream. Borrowers are of two types: honest ones that are assumed to always repay their loans (they only accept loans that they are sure to repay), and dishonest one who will repay the loan only when this is less costly than defaulting. Since Jaffee and Russel assume that the cost of default is fixed an independent of the level of the loan then, for a given interest rate, the cost of repayment and the benefits from default rise proportionally with the amount borrowed, wich makes the probability of default increase with the size of the loan. In effect, Jaffee and Russel explores the incentive a borrower has to repay the loan even when s/he has enough wealth to meet such payments (6). With free entry and competitive lenders [i. e., the zero-profit condition for the insurance firm in the Rothschild and Stiglitz (1976) model], the credit supply curve is a horizontal line until it reaches the point at which the dishonest borrowers start to default. Thereafter the shape of the supply curve depends on the distribution of defaulters. The supply curve is given by the zero-profit condition for lenders so that all rents accrue to borrowers; thus, there is cross-subsidization as lenders cannot discriminate their borrowers due to asymmetric information.

Under the assumption that funds are scarce (or that the proportion of dishonest borrowers is high), the unique credit market equilibrium is at the point where the supply curve of credit starts to rise. This result depends *(i)* on the asymmetric information assumption which precludes the lender from providing different contracts to intrinsically different borrowers who are nevertheless un-distinguishable to the lender, and *(ii)* on the free entry assumption. Figure 2, below, depicts a possible competitive equilibrium A in which all borrowers receive the loan L^*, and paying i^*; this interest rate reflects the probability of

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(6) The case of unwillingness to repay versus the inability to repay a loan (due, e. g., to a crop failure) has been in the centre of the debate in the recent literature on international debt crisis (see Hellwig, 1986a).

default in the population of borrowers, as it provides zero expected profits to lenders. Due to free entry, another lender can offer a contract with a loan size lower than L^* and an interest rate lower than i^*. This contract is preferred by the honest borrower (7) and it provides positive to the new lender (if only honest borrowers choose it); such a contract lies below the supply curve. Dishonest borrowers prefer the old contract as they are subsidized by the (remaining) honest borrowers; hence the contract (L^*, i^*) no longer breacks even and A is not an equilibrium (there is self-selection). If only one contract is allowed (i. e., no separation of types), B is the point that can be sustained as a free entry, competitive equilibrium and is characterized by credit rationing. A separating equilibrium is not sustainable because a borrower know to be dishonest will be refused credit. The advantage of rationing is that, as the loan size is smaller, the proportion of defaulters is low and consequently honest borrowers are subsidizing less dishonest borrowers. But, at B, the rationing equilibrium is characterized by zero default probability! One prediction of this model is that the credit market fluctuates between the rationing equilibrium B and the pooling equilibrium A.

Although not recognized by Jaffee and Russel, their model provides another argument leading to the credit rationing result: clearly, for a given interest rate, lenders prefer low default probability loans; i. e., with indifference curves as in figure 2, the point C is the preferred (equilibrium) contract for lenders as it maximizes their utility subject to the breack-even constraint. At the interest rate given by C, borrowers' aggregate demand is for a higher loan size, implying rationing.

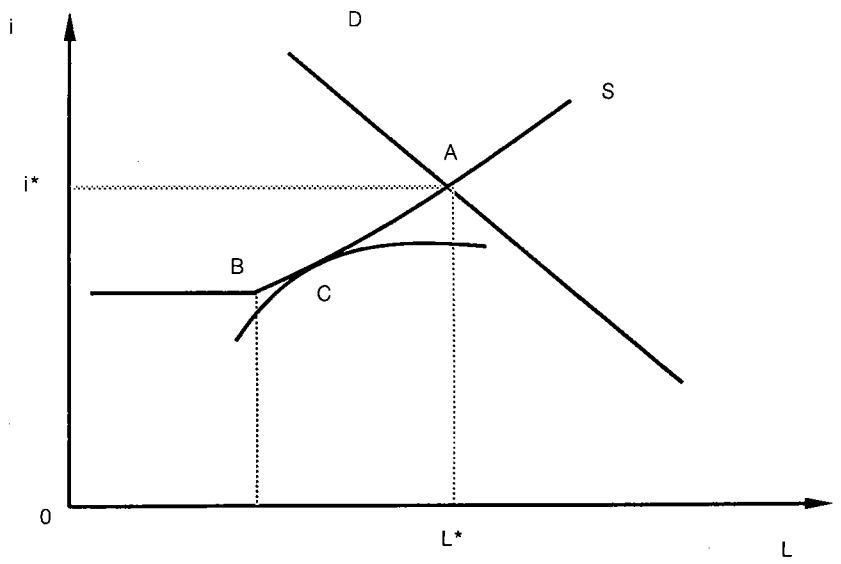

FIGURE 2

(7) Since this borrower never defaults, a lower interest rate loan is attractive for a small decrease in the loan size.

Stiglitz and Weiss (1981) study credit rationing as the case of apparently similar borrowers being treated differently; in particular, some receive loans while others do not, and even if a potential borrower without loans offers to pay a higher interest rate, no lender will provide additional credit. Similar borrowers means that there is essentially one loan contract in the credit market; in particular, the size of the loan is the same for all borrowers and hence the quantity of credit (the analogue of the quantity of insurance in Rothschild and Stiglitz insurance model) does not function as a screening device. Stiglitz and Weiss advance two arguments for equilibrium credit rationing in a competitive market with asymmetric information. The first argument is based on the adverse selection effect; borrowers are of diverse types (where types are private information), and, given their type, their willingness to demand a loan is a decreasing function of the interest rate; i. e., higher interest rates give lower expected profits for a given type. In the Rothschild and Stiglitz insurance environment, an increase in the premium leads low-risk individuals to drop out; similarly, an increase in the interest rate renders low-risk borrower's expected profits negative before the high-risk's one. Thus, higher interest rates leads low--risk borrowers to drop out while the high-risk ones remain. Consequently, there is an interest rate which maximizes the lender's expected profit, and for which the income effect from increasing the interest rate is balanced by the deterioration in the average riskiness of the pool of borrowers; in other words, the supply of funds curve has a mode. Hence the credit market can be characterized by excess demand in equilibrium as lenders profit more from rationing rather than from supplying the amounts demanded by borrowers.

A borrower's willingness to demand a loan depends on his/her type and on the interest rate; hence it could be used as a screen by lenders to establish the true quality of each borrower. However, this is not operative as lenders cannot offer more than one contract (recall that the separating equilibrium is not possible). When a high-risk borrower's application for a loan is rejected, it is not possible for him/her to induce an increase in the supply of funds, since an offer to pay a higher interest rate is type revealing and, rationally, the lender will not provide any credit (i. e., a loan to high-risk borrowers has an expected loss). A fixed level of collateral cannot solve the adverse selection problem either; with a positive but fixed level of collateral in the loan contract the borrower's expected profits are still an increasing function of his/her type for any interest rate. It may happen, however, that the mode of the supply of credit curve is on the righ-hand side of the demand curve, in which case there is no rationing. Hence, Stiglitz and Weiss need the additional hypothesis that the credit is scarce to ensure that the mode of the supply curve lies on the left-hand side of the demand curve.

The second argument in the Stiglitz and Weiss model is based on moral hazard or incentive considerations. When borrowers have access to a large pool of projects with different probabilities of default, an increase in the interest rate has a negative effect on their expected profits for a given project

default probability; hence, the borrower has an incentive to adopt some other project with heavier tails ([8]); this increases (resp. decreases) the borrower's (resp. lenders's) expected profit. All projects in the borrower's investment pool have the same mean, and hence the probability of default, given the interest rate, increases with the riskiness of the project. For small variations in the interest rate and in the relocation of the density mass of the project's probability distribution, lender's expected profits decrease. Thus it is not in their interest to increase the interest rate. Clearly, the incentive effect is less severe when the borrower has some stake in investment; in fact, for a sufficently high collateral, the borrower's and the lender's interests coincide. To preclude this, Stiglitz and Weiss introduce, again, an adverse selection effect. If borrowers are risk averse but differ in wealth (wealth is privately observable only), an increase in the collateral increases the borrower's expected loss; consequently, a less wealthy potential borrower may choose not to invest because of his/her smaller risk tolerance. Conversely, the wealthy borrower can absorb a higher loss and a higher risk, i. e., is willing to adopt a riskier project than the less wealthy one. For a given level of collateral, an increase in the interest rate drives out the low-risk borrower (i. e., the less wealthy), who chooses projects with a higher probability of success. Similarly, for a given interest rate, an increase in collateral drives out the good risk borrowers. Therefore, when the lender is unable to identify the borrowers types, there can be an interior optimum for the collateral. That is, an increase in the collateral increases the average riskiness of the pool of projects adopted by the borrowers. Thus, the adverse selection effect, in the presence of moral hazard, can constraint the use of collateral as an incentive mechanism.

Bester (1985) shows that if the lender can offer more than one type of loan contract with variable levels of collateral and interest rates, then a separating equilibrium exists in which no credit rationing occurs; a contract with a high level of collateral and a low interest rate is preferred by the low risk borrower while a contract with a low level of collateral and a high interest rate is preferred by the high risk one. For the low risk borrower, the decrease in the interest rate compensates enough for the increase in the expected cost of the collateral, as the probability of losing it is sufficiently small. The Stiglitz and Weiss (1986) article is a response to the criticisms that they allowed (studied) few contracts in the loan market in their works (Bester's message is essentially that with enough freedom of contracting in the credit market, such as using collateral *and* interest rates, different risk types can be screened out); in particular, they expand their (1981) article on the moral hazard plus adverse selection case to include the case of jointly variable collateral and interest rates contracts. A pooling equilibrium with rationing exists, where the level of

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([8]) When the distribution functions are symmetric, a flatter distribution has heavier tails, i. e., with more probability mass away from the centre. Limited liability then makes the fat tails distributions more atractive to the borrower.

callateral is equal to the poorest borrower's non-human wealth. When lenders are Cournot-Nash players, they identify conditions for a pooling equilibrium to be sustainable. The essence of Stiglitz and Weiss (1986) is that more degrees of freedom (e. g., more contracts) do not necessarily solve the incentive cum selection problem as one can build a sufficiently complicated model so that the new contracts cannot cope with the incentive and selection effects. Chan and Thakor (1987) obtain the startling result that a high-quality borrower with unlimited collateral may be rationed; for a given contract that extracts all the surplus from a high-quality borrower, the low-quality one is also atracted to it so that some high-quality borrowers do not receive loans. The bank cannot change the interest rate or collateral without violating the reservation utility or outside opportunities of high quality borrowers. Hellwig (1986b) shows that by increasing the number of plays in the game between borrowers and lenders, the pooling or the separating equilibrium can be singled out as perfect and stable (in the Kohlberg and Mertens sense), depending on who plays first.

Hart (1986) notes that the credit contract used in the above articles assumes private information with respect to the return on a project when the investment is solvent, but the value of the output is a costlessly available public information when there is insolvency. This is a convenient point to start to survey the literature that explains credit rationing because of inspection or observation costs.

Diamond (1984) explains the existence of intermediaries (i. e., banks) when observing the productivity of an investment is costly. When an investment is financed by more than one lender, only the intermediary needs to verify the true productivity of the firm and so economises on observation costs. Gale and Hellwig (1985) and Williamson (1984) seek to identify what is the optimal contract between an entrepreneur and a saver when the productivity of an investment is not costlessly observable by the latter (the uninformed agent). Building on Townsend (1979), they show that the optimal contract is a standard debt contract characterized by no verification and a fixed repayment in case of fulfillment of the original terms of the contract and, in case of default, verification occurs with all production captured by the lender.

Williamson (1984) uses the fact that an increase in the interest rate increases the probability of default, other things being equal; this implies that the lender's expected profit function is concave, and hence there is an interior maximum for the lender's optimization problem. Thus, a rise in the interest rate increases the revenue to the lender but, as it increases also the probability of default, the expected cost of monitoring the ex-post productivity of the project rises, lowering the expected return; at the point of sure bankruptcy the lender's marginal expected return is negative as the observation cost is certain and the expected revenue from collecting the loan is zero. At the lender's optimal lending point, there may or may not be rationing (more projects than available lenders). If there is rationing the interest rate cannot be used to clear the market as an increase in the interest rate does not benefit lenders or bor-

rowers with loans; no other potential lenders enter the market as a loan's expected return is negative. It follows that an increase in the supply of funds through a loosening in the monetary stance reduces the number of borrowers without loans with no substantial impact on the interest rates. This result is the clearest proposition of the availability doctrine. Williamson's contribution is important as he is able to show that a small departure from the standard model can lead to the break-down of the interest-rate mechanism; furthermore, adverse selection or moral hazard are not needed for this to happen.

Gale and Hellwig (1985) derive the debt contract as the optimal contract under asymmetric information, when observing the productivity or the return of an investment is costly; this observation cost is, however, given. The lender, unusually, is assumed to have total control of the investment and knows all the possible returns (the distribution function) of the investment the borrower adopts (thus, the moral hazard problem and adverse selection are banished); however, only the borrower observes costlessly the actual return of the investment. As the observation cost is not small, it is not sensible (i. e., efficient) for the lender (the uninformed party) to always observe the true productivity of the debt-financed investment. The presence of private information, and the borrower's incentive to keep interest payments as low as possible, lead the borrower to misrepresent the actual return of the project by claiming that the lowest return has occured; this effect is similar to that discussed in the sharecropping literature (Stiglitz, 1974). Hence the lender, in the absence of verification, can only agree to finance those investments which, even in the worst states (the lowest possible return), give him/her some profit.

Consequently, incurring observation costs can be beneficial to both parties as the return a borrower can claim will be higher than the lowest return of the investment and hence more funds will be available. Moreover, the decision to observe the return can be interpreted as the lender declaring the borrower bankrupt; that is, if the borrower claims a low return (which is insufficient to cover the interest rate agreed upon) the lender incurs the cost of verifying the true productivity (i. e., checking the books) and keeps the production to himself. Then the borrower has no interest to always claim a low return (e. g., when the return is more than what is needed to repay the loan plus interest, the borrower does better by repaying the loan and keeping the surplus to him/herself). It follows that bankruptcy occurs only when the state of the world is bad, and so there is a partial risk sharing in the standard debt contract.

The observation cost induces a wedge between the full information investment optima and the one when the information on the ex-post productivity of an investment is asymmetric. The optimal contract, then, is the one providing an investment level between the two. Credit rationing is interpreted as the under--investment with respect to the full information level; but this first best level cannot be achieved because the bankruptcy probability is positive and because there is a bankruptcy cost. In other words, at the full-information optimum, a decrease in the investment level has secondary effects on the marginal productivity of the investment, but a first-order effect on the probability of bankruptcy.

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