

Kirstein, Roland

**Working Paper**

## The New Basle Accord, Internal Ratings, and the Incentives of Banks

CSLE Discussion Paper, No. 2000-06

**Provided in Cooperation with:**

Saarland University, CSLE - Center for the Study of Law and Economics

*Suggested Citation:* Kirstein, Roland (2000) : The New Basle Accord, Internal Ratings, and the Incentives of Banks, CSLE Discussion Paper, No. 2000-06, Universität des Saarlandes, Center for the Study of Law and Economics (CSLE), Saarbrücken

This Version is available at:

<https://hdl.handle.net/10419/23064>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

# The New Basle Accord, Internal Ratings, and the Incentives of Banks

by Roland Kirstein  
Center for the Study of Law and Economics\*  
Discussion Paper 2000-06

June 2001

## Abstract

The Basle Accord of 1988 regulates how much equity banks must set aside as a cushion against the default risk. In its 1999 proposal for a new Accord, the Basle Committee seeks to introduce different equity ratios for customers of different risk levels. The proposal strongly favors external ratings as a means of risk determination. German banks, on the other hand, demand acknowledgement of their internal ratings.

This paper shows that, even if assumed that banks have better diagnosis skill than external rating agencies, external ratings are better able to implement the goals of the Basle Committee than internal ratings. This is due to a lack of incentives to truthfully reveal their diagnosis results. These incentives may be provided by supervision of internal ratings, even if imperfect and only occasional. However, this requires that a fine be imposed if the supervising authority comes to a result different from the internal rating assigned by the bank.

**JEL-Classification:** *G21, D 81, K00*

**Encyclopedia of Law and Economics:** *5850, 0790, 9300*

**Keywords:** *diagnosis theory, imperfect decision making, credit worthiness tests.*

---

\*Universität des Saarlandes, Bldg. 31, D-66041 Saarbrücken, Tel.+49-681-302-3582, fax +49-681-302-3591 (email rol@mx.uni-saarland.de, homepage <http://kirstein.home.pages.de>). I'm indebted to Brandon Ahearn, Jürgen Eichberger, Ralf Elsas, Yves Hilpisch, Jan Pieter Krahen, Johann Graf Lambsdorff, Martin Nell, Caspar Rose, Frank Schmidt, Dieter Schmidtchen, Peter Strobel, to other participants of the European Association of Law and Economics conference in Ghent, September 2000, as well as seminar participants at the Universities in Frankfurt/Main and Göttingen, and to the anonymous referees for valuable comments.

# Contents

<b>1</b>	<b>Introduction</b>	<b>2</b>
<b>2</b>	<b>Internal rating</b>	<b>5</b>
2.1	Outline of the model . . . . .	5
2.2	Basic model: no diagnosis . . . . .	6
2.3	Imperfect internal diagnosis . . . . .	8
2.4	Internal rating and supervision . . . . .	14
<b>3</b>	<b>External rating</b>	<b>16</b>
<b>4</b>	<b>Conclusion</b>	<b>18</b>
	<b>Appendix</b>	<b>20</b>
	<b>References</b>	<b>23</b>

## 1 Introduction

In June 1999, the Basle Committee<sup>1</sup> proposed a revision of the Basle Accord, to become effective in 2004.<sup>2</sup> The Accord determines how much equity internationally active banks must set aside against their loans.<sup>3</sup> According to the Basle Accord of 1988, banks are required to hold 8 percent of their commercial customers' loans as equity.<sup>4</sup> Obeying a minimum equity ratio is costly since the banks may thereby forego profitable deposit arrangements.<sup>5</sup>

The 1988 Basle Accord does not distinguish between customers in business areas with various levels of risk. This may lead to adverse incentive effects: if the credit cost burden is the same for high and low risks, and banks charge higher interest rates for more risky loans, then profit maximizing bank managers are tempted to replace low-risk customers with high risk customers.

The Basle Committee's proposal requires a higher equity ratio for loans to high-risk customers, and a reduced equity ratio for low risk loans. Credits to low-risk customers less less expensive for the banks, whereas loans to high-risk customers

---

<sup>1</sup>The Committee is hosted by the Bank for International Settlements in Basle and consists of representatives of the central banks and the supervisory authorities of the G10 countries, plus Switzerland and Luxembourg, see SHELDON (1996a, 709).

<sup>2</sup>In the meantime, the Basle Committee has announced that the new Accord will not become effective before the year 2005, see MEISTER (2001).

<sup>3</sup>ECONOMIST (1999, 100).

<sup>4</sup>The figure of 8 percent seems to be a rule of thumb rather than the result of optimization calculus. The Basle Committee did not give any hint why it is 8 percent instead of, say, 4 or 16 percent, see BLATTNER (1995, 720). Perfect deposit insurance would only be provided by an equity ratio of 100 percent. However, this would leave no depositors in the bank's balance sheet, see HELLWIG (1995, 732f.).

<sup>5</sup>See SANTOS (2000, 7) who presents a comprehensive survey on banking regulation.

become more expensive. In general, the riskiness of a customer is operationalized by the (expected) probability of a default, which is derived from historical data or from an evaluation of the project.<sup>6</sup>

The current discussion focuses on how loan risk should be determined. One way to make different levels of risk comparable is credit rating, i.e. the attempt to aggregate a large amount of data into one figure or letter.<sup>7</sup> The Basle Committee and the US authorities prefer external rating agencies<sup>8</sup> to do this, whereas German banks favor internal ratings.<sup>9</sup>

It is expected that the Basle Committee's proposal will lead to a considerable decrease in the average equity requirement.<sup>10</sup> Nonetheless, German banks take the Basle committee's strong bias towards external ratings as a serious threat. There are several reasons for this position: the German banks' desire to maintain their influence in the capital markets, the fact that only a few companies in Germany already hold a costly rating,<sup>11</sup> and the idea that German banks have a close relation with their customers and hence a better knowledge of their credit worthiness than external rating agencies. In the meantime, the Basle Committee has published amendments to its proposal that consider internal ratings more favorable.

From the viewpoint of diagnosis<sup>12</sup> theory, however, the original position of the Basle Committee makes sense. Diagnosis skill, i.e. the ability to distinguish high from low risk, is only one of the two factors that are crucial to a comparative analysis of diagnosis institutions. Equally important are the incentives of the actor who performs the diagnosis. Diagnosis theory shows that it can be rational to react non-contingently on a diagnosis result, even if the result is based on superior diagnosis skill. Hence, taking into account the goals of the new Basle Accord, it might be better for the Committee to rely on the inferior diagnosis skill of rating agencies which have flawed incentives.

The "second pillar" of the new Basle Accord is the "Supervisory Review Process", according to which a supervising authority evaluates how banks handle their risk assessments. If the supervisor detects potential risks, he may make

---

<sup>6</sup>See BÖRSEN-ZEITUNG (1999) and SHELDON (1996b). The new proposal does not provide a clear answer to the question whether an optimal equity ratio scheme for the respective risk-classes exists. ALTMAN/SAUNDERS (2001) distinguish five different risk-classes and propose different equity ratios for them.

<sup>7</sup>See KRAHNEN/WEBER (2001, 5). The alternative is the use of risk-management models.

<sup>8</sup>Such as Standard and Poor or Moody's. These firms' rating standards are available under [www.standardandpoors.com](http://www.standardandpoors.com) and [www.moody.com](http://www.moody.com).

<sup>9</sup>See BÖRSEN-ZEITUNG (1999). Surprisingly, the Basle Committee treats firms without rating as medium risks. This part of the proposal is excluded from my analysis.

<sup>10</sup>German Banks, on the other hand, have estimated that more equity is required than under the old Accord, see MEISTER (2001).

<sup>11</sup>STELTZNER (1999). In FAZ (2000), it is estimated that only 40 German firms hold a rating, among them no small-and-medium enterprises. An external rating of such a company would cost about 25.000 Euro per year.

<sup>12</sup>In the literature, diagnosis is often called "screening", a term that may lead to confusion with the concept of screening contracts.

proposals on how to improve the bank's risk-management. In exceptional cases, the supervisor may even demand a bank to hold a higher equity ratio. The German Bundesbank is quite optimistic that, given this supervision procedure, internal ratings will have a good chance of finding acknowledgement.<sup>13</sup> However, the supervisory review process aims only at improving the quality of the internal ratings and leaves out the banks' incentives out of focus.<sup>14</sup> This paper presents a diagnosis model that takes into account the diagnosis skill as well as the incentives of the institution determining an applicant's credit risk. The model allows for a comparative analysis of external rating, of internal rating by a bank's credit department, and of internal rating combined with supervision by an authority.

The results of my model show that, even though internal ratings are based on better knowledge of the customers, this is outweighed by the lack of the banks' incentive to truthfully reveal their diagnosis results. Thus, in comparison to internal ratings without supervision, external ratings are better able to implement the goals of the Basle Accord. Supervision, even if imperfect and only occasional, may provide the necessary incentives of the bank. However, a prerequisite for this is the imposition of a fine for incorrect ratings, a possibility not yet provided for in the Basle Committee's proposal. The "Supervisory Review Process" seems to be insufficient to achieve the necessary impact on the bank's incentives.

Three basic assumptions are made in this paper:

- banks have higher diagnosis skill than external institutions such as rating agencies or supervision authorities;
- external rating agencies or supervision authorities have an incentive to provide ratings as accurate as possible, whereas this is not necessarily true for banks;
- it is assumed that the diagnosis results are private information, whereas the conditions of a credit contract are verifiable.

Using this approach, it is not the purpose of this paper to discuss whether the Basle Accord's equity requirements or the German banks' proposal make sense,<sup>15</sup> especially if compared to other means of deposit insurance.<sup>16</sup> It is also beyond the focus of this paper to illustrate how credit-worthiness ratings are (or

---

<sup>13</sup>MEISTER (2000, 3 f.).

<sup>14</sup>See DEUTSCHE BUNDESBANK (2001, 31).

<sup>15</sup>HELLWIG (1995, 734 f.) objects that equity rules may fail to work in a dynamic framework, may cause macroeconomic problems and address the problem of excessive risk-taking only in a crude and indirect way. BLUM (1999) demonstrates, using a two period model, that capital adequacy requirements may even increase the riskiness of a bank's credit portfolio. BLATTNER (1996), on the other hand, claims that there "is hardly an alternative".

<sup>16</sup>BLATTNER (1995, 720) raises the question whether these means actually are complements or substitutes.

should be) performed. The internal incentive problem that might arise between a bank's management and its credit department staff is not discussed,<sup>17</sup> nor are the incentives of regulators and supervising institutions,<sup>18</sup> nor the macroeconomic effects of the Basle Accord.<sup>19</sup>

The sole focus of this paper is to analyze which institutional setting is better suited to the new Basle Accord's goal of assigning higher equity ratios to higher risks. My analysis makes use of the insights of diagnosis theory, taking into account the incentive of profit-maximizing banks. Until now, this aspect seems to have been neglected in the political debate regarding revision of the Basle Accord.

## 2 Internal rating

### 2.1 Outline of the model

Consider a risk-neutral, price-taking bank that is faced with two types of credit seeking customers. The loan amount is normalized to one. The probability of default depends on the true but unknown type of applicant. The bank screens the credit applicants; the diagnosis result is private information. After the diagnosis, the bank openly assigns one of two risk classes or rejects the applicant. Thus, the assigned risk class might deviate from the true diagnosis result, but when a risk class is assigned, it governs the bank's returns and credit costs.<sup>20</sup>

Let  $t \in \{H; L\}$  denote the possible types of applicants, where  $H$  stands for a high probability of success (or a low default probability), and  $L$  for a low probability of success. If the customer goes bankrupt, the return to the bank is assumed to be zero. The bank receives the agreed upon interest rate with probability  $q_t$ , with

$$q_H > q_L$$

However, the distribution of the types is known: Type  $H$  appears with probability  $\pi$ ; hence the probability of type  $L$  is  $1 - \pi$ . If the bank gives credit, there are two reasons why it has to assign a risk class to the customer:

- the new Basle Accord forces the banks to set aside equity according to the risk class;

---

<sup>17</sup>See, e.g., FEES/SCHIEBLE (1999) on this.

<sup>18</sup>GEHRIG (1995, 748) assumes that supervisors have a preference for the prevention of bankruptcy of banks rather than for the maximization of overall welfare; see also the brief discussion in BLATTNER (1995, 720).

<sup>19</sup>See, e.g., BASLE COMMITTEE (1999).

<sup>20</sup>Of course, this models only a highly stylized version of the proposed new Basle Accord.

- the market interest rates for the two risk classes differ empirically.<sup>21</sup>

Let  $d$  stand for the decision of the bank, with  $d = \{n; l; h\}$ . The assignment of the high quality risk class, representing a low default risk, is denoted as  $d = h$ . The assignment of the low quality risk class (i.e., a high default risk) is denoted as  $d = l$ . To reject the customer is denoted as  $d = n$ . In case of  $d = l$ , the required equity ratio and hence the bank's credit costs are higher than in case of  $d = h$ . The credit costs are denoted as  $c_d$ , with

$$c_h < c_l$$

The interest rates are denoted as  $i_d$ , with

$$i_h < i_l$$

Since the bank is assumed to be a price-taker, the two interest rates are exogenously given. However, the results to be derived below would hold for any value of  $i_h$  and  $i_l$  respectively, as long as the interest rate for the more risky customer is higher than the one for the less risky one.

I assume that banks are effectively prevented from applying asymmetric combinations of interest rate and credit costs, namely  $(c_h, i_l)$  and  $(c_l, i_h)$ : if a bank has assigned a risk class  $d$ , this is public information; thus, it can easily be enforced that interest rate and equity cushion are set in accordance with the assigned risk class. The only opportunity to act unlawful is to assign a risk-class that deviates from the actual diagnosis result. Therefore, in this model the banks discretion is limited to applying either  $(c_h, i_h)$  or  $(c_l, i_l)$ .

The banks payoff is based on two more factors: the success probability  $q_t$ , with  $t \in \{H; L\}$ , and the assigned risk class  $d \in \{n; h; l\}$ . If the bank rejects the customer, it does not have to bear credit costs and does not collect interest:  $i_n = c_n = 0$ . Thus, the general formulation for the bank's payoff is

$$q_t i_d - c_d$$

Let me define  $\Delta i = i_l - i_h$  and  $\Delta c = c_l - c_h$  for ease of the exposition. Table 1 summarizes the parameters that are relevant to the bank's decision situation.

Note that the parameters  $i_d, q_t, \pi$  are exogenously given, whereas the parameters  $c_h$  and  $c_l$  belong to the policy instruments used by the Basle Committee to influence a bank's behavior. I define the average probability of success based on a prior  $\pi$  as  $\Theta(\pi)$ , with  $\Theta(\pi) = \pi q_H + (1 - \pi) q_L$ .

## 2.2 Basic model: no diagnosis

I start the analysis of the model by assuming for the moment that the bank does not screen the applicant. In this case, its decision is based on a simple

<sup>21</sup>It is observable that the interest rates are higher if the borrower presents a higher risk, see MACHAUER/WEBER (1998).

Table 1: Internal rating without diagnosis

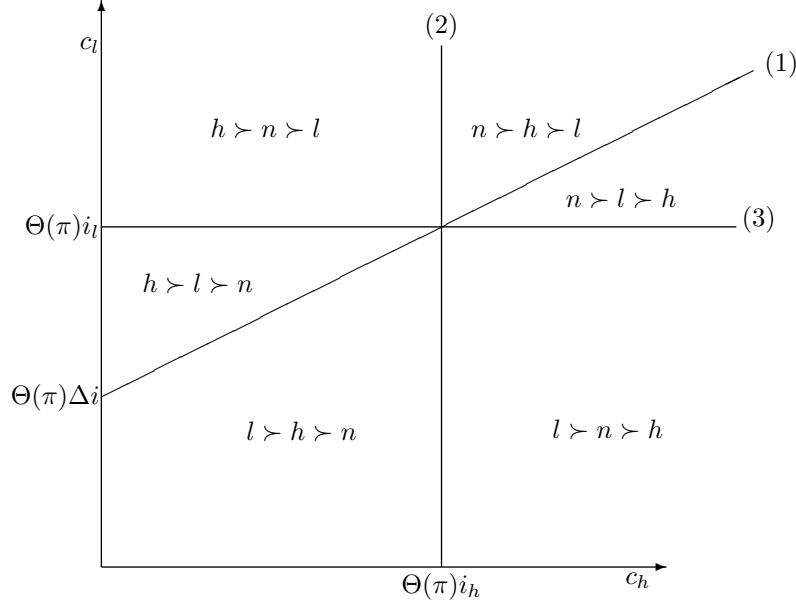
applicant's type bank's decision	$t = H$	$t = L$
$d = h$	$q_H i_h - c_h$	$q_L i_h - c_h$
$d = l$	$q_H i_l - c_l$	$q_L i_l - c_l$
$d = n$	0	0

expected payoff comparison which can already be derived using the parameters shown in table 1. The following proposition can easily be proven by comparing the expected payoffs connected to the available options.

**Proposition 1:** Given  $i_d, q_t, \pi, c_d$  with  $d \in \{h; l; n\}, t \in \{H; L\}$ ,  $c_l > c_h$ ,  $i_l > i_h$ , and  $q_H > q_L$ , then the bank prefers

- (1)  $d = h$  to  $d = l \Leftrightarrow \Delta c > \Theta(\pi)\Delta i$
- (2)  $d = h$  to  $d = n \Leftrightarrow c_h < \Theta(\pi)i_h$
- (3)  $d = l$  to  $d = n \Leftrightarrow c_l < \Theta(\pi)i_l$

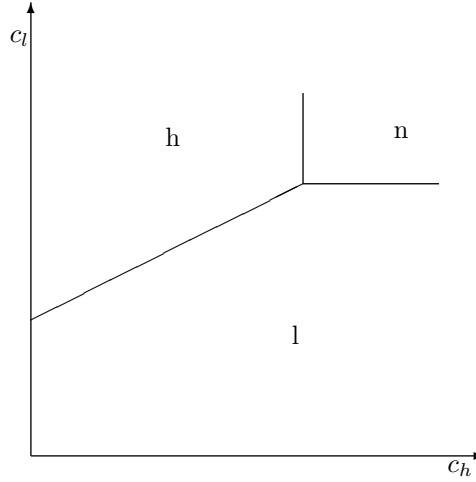
Figure 1: Internal Rating without diagnosis





These results are visualized in figure 1 which shows the bank's preferred action for all possible combinations of  $c_l$  (on the vertical axis) and  $c_h$  (on the horizontal axis). E.g., in the two upper left areas (above the diagonal line labeled (1) and left of the vertical line labeled (2)),  $d = h$  is the optimal decision of the bank: in the uppermost area,  $h$  is preferred to  $n$  and  $n$  is preferred to  $l$ , which is symbolized by  $h \succ n \succ l$ . In the two lower right areas (below the horizontal line (3) and below the diagonal line (1)) the optimal decision is  $d = l$ . If both  $c_l$  and  $c_h$  are very high (above (3) and to the right of (2)), then no applicant will be granted a credit ( $d = n$  is optimal).

Figure 2: Optimal decision without diagnosis



Note that the three conditions that were derived in Proposition 1 lead to a partition of the set of possible  $c_l$ - $c_h$ -values, as it is easily visible in figure 1. Furthermore, note that if  $i_l > i_h$ , then the upwards sloping line in figure 1 that represents condition (1) in proposition 1 has a positive intercept with the vertical axis, since  $\Theta(\pi) = \pi q_H + (1 - \pi)q_L > 0$ , and slope 1. Therefore, the intersection of the three lines in figure 1, representing the three conditions in Proposition 1, lies always above the 45°-line, i.e. the area where  $c_l > c_h$ . Figure 2 is a simplified version of figure 1, showing only the optimal decision for each of the possible combinations of  $c_h$  and  $c_l$ .

### 2.3 Imperfect internal diagnosis

The basic model presented in the previous section assumes the bank is unable to determine the applicants' true type and therefore relies on pure chance. In

this section, the model is refined by introducing diagnosis.<sup>22</sup> When diagnosing a new customer, the bank receives a diagnosis result (a signal) that is correlated with the potential customer's type. The signal is denoted as  $s \in \{h; l\}$  and assumed to be correlated with the true type. Let

$$r := \Pr(s = h|t = H)$$

be the probability that signal  $s = h$  occurs correctly and

$$w := \Pr(s = h|t = L)$$

be the probability that this signal occurs incorrectly. Thus, the error probabilities are  $1 - r$  and  $w$ , respectively. The signal is assumed to be informative:  $r > w$ . However, the signal is not perfect:  $r < 1$  and  $w > 0$ . This case is called "positive, but imperfect diagnosis skill".<sup>23</sup> For a bank of perfect diagnosis skill,  $r = 1$  and  $w = 0$  hold.<sup>24</sup> The other extreme case would be "zero diagnosis skill", i.e.,  $r = w$  regardless of the value of  $r$  and  $w$ . In this case (which was implicitly assumed in section 2.1) the diagnosis result is independent of the true, unknown type of the credit applicant.

Having observed the signal, the bank updates its beliefs according to the Bayes' rule. Let me denote the posterior probability that the true type is  $t = H$  as  $\mu$  if the signal was  $s = h$ , and as  $\nu$  if the signal was  $s = L$ , hence

$$\mu := \Pr(t = H|s = h)$$

and

$$\nu := \Pr(t = H|s = l)$$

. The ex-post average probability of success is denoted as  $\Theta(\mu) = \mu q_H + (1 - \mu)q_L$  and  $\Theta(\nu) = \nu q_H + (1 - \nu)q_L$ , respectively. The relations between posteriors and priors are summarized in the following Lemma:<sup>25</sup>

**Lemma 1:**  $r > w$  and  $q_H > q_L$  imply  $\mu > \pi > \nu$  and  $\Theta(\mu) > \Theta(\nu)$ .

<sup>22</sup>The model presented here was outlined in KIRSTEIN/NEUNZIG (1999), criticizing the seminal paper of BROECKER (1990) for not having taken into account the possibility that a bank may have incentives to disregard the diagnosis result when making its credit decision. The idea that it can be rational to disregard a diagnosis result and to instead base a decision on a rule of thumb is based on the work of HEINER (1983), (1986), (1990). His work refers to signal detection theory, see GREEN/SWETS (1966).

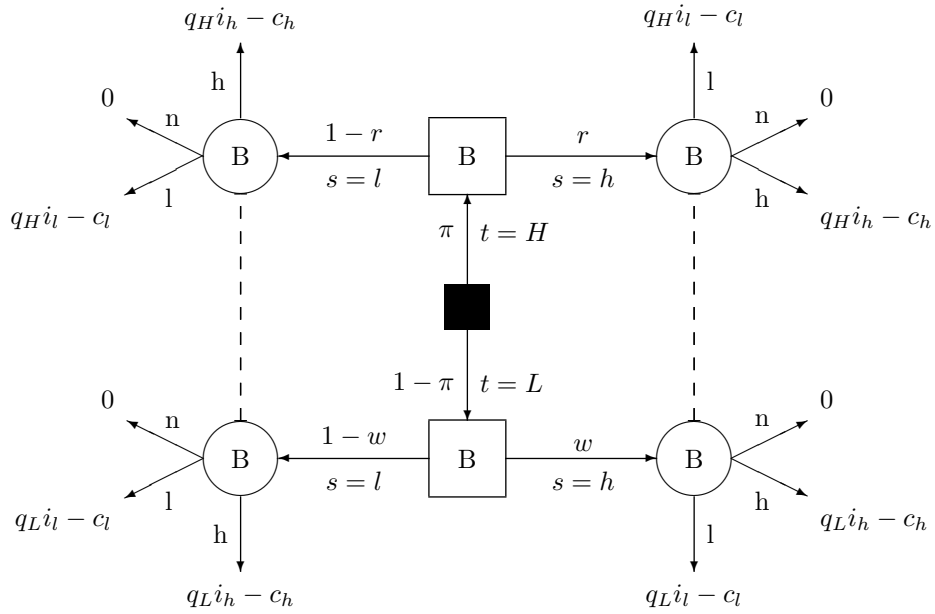
<sup>23</sup>Compare this approach to HAUSWALD/MARQUEZ (2000). In the literature on binary diagnosis, the error probabilities are often set equal:  $1 - r = w$ , see e.g. CAO/SHOUYONG (1999). In such a model, positive diagnosis skill means  $r > 1/2$ ; this simplified approach is used in the subsequent sections to model the diagnosis skill of supervising authorities and of external rating agencies.

<sup>24</sup>DELL'ARICCIA (2000) assumes perfect diagnosis skill, but distinguishes between old customers (the bank has already the information on the type) and new customers (the bank has to spend diagnosis costs in order to perfectly learn the customer's type). Other authors assume that banks only screen with a probability smaller than one, see e.g. COVITZ/HEITFELD (1999). Here, diagnosis costs are neglected and the bank always screens.

<sup>25</sup>The proof is in the Appendix, see page 20.

The bank's decision problem is visualized in figure 3. The tree starts with a chance move, determining the true but unknown type of the applicant. This is symbolized by the darkened box in the center of figure 3. The bank, denoted as  $B$ , then screens the applicant and receives an informative signal,  $s \in \{h; l\}$ . Knowing the diagnosis result, the bank finally grants a credit by assigning a risk class (either  $d = h$  or  $d = l$ ), or rejects the customer ( $d = n$ ).

Figure 3: Decision tree with internal rating



It is assumed that the signal  $s$  is the bank's private information, whereas the contract conditions are observable to third parties. This makes it possible for the bank to assign a risk class that deviates from the diagnosis result. To react in accordance with the signal means to choose  $d = s$ , whereas to deviate means  $d \neq s$ . If credit is granted, then the conditions of the contract are governed by the assigned risk class. I assume the authority can easily observe whether the credit conditions coincide with the bank's internal rating decision  $d$ .<sup>26</sup> Hence,  $c_d = i_d$  is easily enforced for both  $d = h$  and  $d = l$ . It is excluded that a bank

<sup>26</sup>Note that this observation does not require the assumption that the authority has positive diagnosis skill with respect to the true, unknown type  $s$  of the credit applicant. In the subsequent section, the authority is assumed to have positive diagnosis skill.

demands  $i_h$  and only sets aside  $c_l$ .

The bank's optimal decision not only depends on the parameters  $\pi, i_d, q_t$  and  $c_d$ , but also on the observed diagnosis result, as Proposition 2 demonstrates. For the proof, simply compare the expected payoffs.

**Proposition 2:** Given  $q_t, \pi, c_d, i_d$  with  $d \in \{h; l\}, t \in \{H; L\}$ ,  $c_l > c_h$ ,  $i_l > i_h$ , and  $q_H > q_L$ . If the diagnosis result was  $s = h$ , then the bank prefers

$$(4) \quad d = h \text{ to } d = l \Leftrightarrow \Delta c > \Theta(\mu)\Delta i;$$

$$(5) \quad d = h \text{ to } d = n \Leftrightarrow c_h < \Theta(\mu)i_h;$$

$$(6) \quad d = l \text{ to } d = n \Leftrightarrow c_l < \Theta(\mu)i_l.$$

If the diagnosis result was  $s = l$ , the bank prefers

$$(7) \quad d = l \text{ to } d = h \Leftrightarrow \Delta c < \Theta(\nu)\Delta i;$$

$$(8) \quad d = h \text{ to } d = n \Leftrightarrow c_h < \Theta(\nu)i_h;$$

$$(9) \quad d = l \text{ to } d = n \Leftrightarrow c_l < \Theta(\nu)i_l.$$

Figure 4 shows the bank's optimal decisions contingent on the policy parameters  $c_l$  and  $c_h$ . The upper right system, which is labeled by (4), (5), and (6), refers to the situation where the bank has observed the diagnosis result  $s = h$ . The lower left system, labeled as (7), (8), and (9), indicates the optimal decision after having observed the diagnosis result  $s = l$ . These labels refer to the conditions in Proposition 2.

$\Theta(\mu)$  and  $\Theta(\nu)$  are the intersections of the diagonal lines in figure 4. Recall Lemma 1: if  $r > w$  and therefore  $\mu > \nu$ , holds as well as  $\Delta i > 0$ , then the (4) lies above (7).<sup>27</sup>

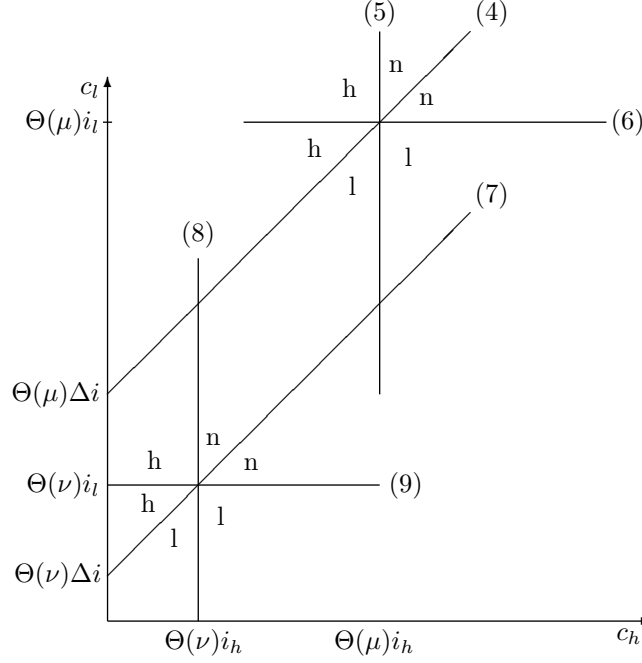
Let me now define a bank's plan for reacting to each of the possible signals as a (pure) "*reaction strategy*".<sup>28</sup> A reaction strategy consists of two plans, the first of which is the intended reaction to the diagnosis result  $s = h$ , and the second part is the intended reaction to  $s = l$ . E.g., the reaction strategy (ln) is the plan to react with  $d = l$  if the observed signal is  $s = l$ , and with  $d = n$  if the signal is  $s = h$ .

Given the notion of reaction strategies, truthful revelation of the internal diagnosis result means choosing the reaction strategy (hl), because this reaction

<sup>27</sup>Figure 4 shows the case in which the intercept of (4) is greater than (9). This relation might also be the opposite one, which would have, however, no impact on the main result of this section.

<sup>28</sup>A mixed reaction strategy is a pair of conditional probabilities with which the decision-maker plans to carry out an action, given a certain diagnosis result. Since the expected payoffs are linear in these probabilities, only corner solutions are optimal. Therefore, mixed reaction strategies can be neglected here.

Figure 4: Internal rating with diagnosis



strategy is characterized by  $d = s$ . If the bank chooses this reaction strategy, it is certain that it sets aside the appropriate amount of equity for all credit customers served. If the bank chooses another reaction strategy, it is possible that the resulting equity sum will be appropriate, but this is only a matter of pure chance, a result not ultimately satisfactory to a regulator.

Figure 5 simplifies figure 4 and shows the optimal reaction strategy choice for the possible values of  $c_l$  and  $c_h$ . Obviously, the reaction strategy (hl) is never optimal for the bank. This is due to the assumptions  $r > w$  and  $i_l > i_h$ . Of course, this result can not only be shown graphically, but can also be proven algebraically: If (hl) were optimal, then the conditions (4), (5), (9), and (7) would be simultaneously true. (4) and (7) is equivalent to

$$\Theta(\nu)\Delta i > \Delta c > \Theta(\mu)\Delta i$$

which implies  $\nu > \mu$ . However, this is a contradiction to  $r > w$ . Therefore, the following proposition is proven:

**Proposition 3:** Given  $r, w, q_t, \pi, c_d, i_d$  with  $d \in \{h; l; n\}$ ,  $t \in \{H; L\}$ ,  $c_l > c_h$ ,  $i_l > i_h$ ,  $q_H > q_L$ , and  $r > w$ . Then the bank will never choose the reaction strategy (hl).

Figure 5: Internal rating and optimal reaction strategies

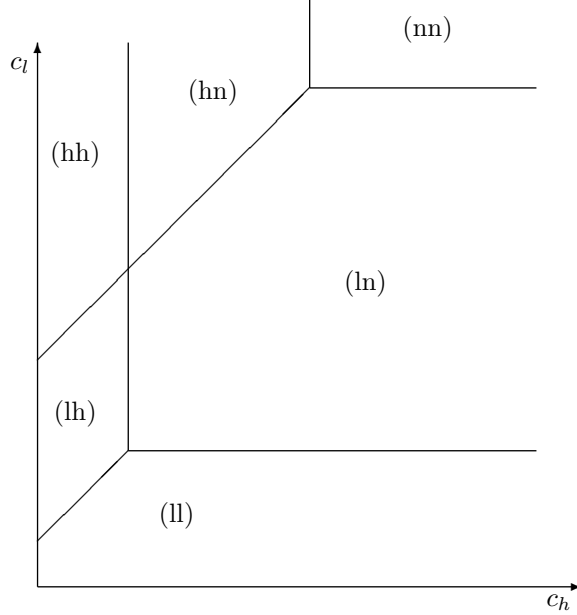


Figure 5 makes obvious that the “Supervisory Review Process”, as proposed in the new Basle Accord, does not provide the bank’s incentives to truthfully reveal its diagnosis result. According to the “Supervisory Review Process”, the supervisor may make suggestions to the bank on how to improve the quality of its risk management. However, even if  $r$  is increased and  $w$  is decreased, the result of Proposition 3 is still true. Additionally, the supervisor may increase  $c_h$  or  $c_l$  (or both) if a bank fails to comply. Yet, this also does not implement the choice of the reaction strategy (hl). Facing a higher equity requirement, the bank may switch from the decision for (hh) to (hn) or from (ll) to (ln), but the structure of figure 5 remains as it is and (hl) is never the optimal choice of the bank.

The fear that internal rating may tempt credit officers to underestimate credit risks was already expressed by KRAHNEN/WEBER (2001, 16), who demand that a rating system should take incentive problems into account. In the framework of my model, underestimation of default risk is modeled as the choice of reaction strategies that provide more favorable credit conditions for applicants if the diagnosis result indicates the more risky types ( $s = l$ ), i.e. (lh), (nh), or (hh).

## 2.4 Internal rating and supervision

Consider a supervising authority that is unable to observe the diagnosis result the bank has internally derived, but has access to the bank's data and may itself evaluate the credit customers. Denote the diagnosis results of the authority as  $a \in \{h; l\}$ . It may impose a fine  $F \geq 0$ , to be paid by the bank if the authority's diagnosis result differs from the risk class  $d \in \{h; l\}$  the bank has assigned (i.e., if  $a \neq d$ ).<sup>29</sup> The supervising authority is assumed to have undistorted preferences: it prefers to assign the appropriate risk class to the bank's customers and it does not impose the fine if its diagnosis confirms the bank's decision ( $a = d$ ). However, the diagnosis skill of the authority is assumed to be lesser (yet positive) than the bank's.

Let  $\lambda$  be the probability of a correct assignment of a risk class:

$$\lambda = \Pr(a = h|t = H) = \Pr(a = l|t = L)$$

Hence,  $1 - \lambda$  is the probability of a wrong diagnosis result:

$$\lambda = \Pr(a = h|t = L) = \Pr(a = h|t = L)$$

Positive diagnosis skill means  $\lambda > 1 - \lambda$ , which is equivalent to  $\lambda > 1/2$ . If the diagnosis skill of the authority is positive, but worse than the bank's, this implies  $r > \lambda > 1 - \lambda > w$ .

Since  $s$  is not observable to outsiders, the authority does not always punish a deviation of the bank's decision  $d$  from the bank's diagnosis result  $s$ . Rather, the authority punishes a deviation between  $d$  and its own diagnosis result  $a$ . At first glance, punishment for behavior that is only allegedly wrongful may appear unjust or even strange. However, this simply reflects the fact that law enforcement authorities do not perfectly know what actually has occurred in the past and therefore may commit errors. They nevertheless can have an incentive compatible impact on the supervised actors.<sup>30</sup>

Despite the possibility of "judicial" errors, imposed fines may positively influence the bank's incentives if the diagnosis skill of both the supervising authority and the bank are satisfactory, as the following Lemma demonstrates.<sup>31</sup>

**Lemma 2:** Given  $r, w, \pi, \lambda, F$  with  $r > \lambda > 1 - \lambda > w$  and  $\lambda > 0.5$ .

Then, the probability of a fine is smaller in case of truthful revelation of the bank's diagnosis result ( $d = s$ ) than in case of  $d \neq s$  if, and

<sup>29</sup>Note that this concept substantially differs from the "Supervisory Review Process" proposed by the Basle Committee, according to which the supervisor may at most increase the equity ratio a bank has to apply. For simplicity I assume the authority does not scrutinize cases in which no credit was granted ( $d = n$ ).

<sup>30</sup>See, e.g., KIRSTEIN/SCHMIDTCHEN (1997).

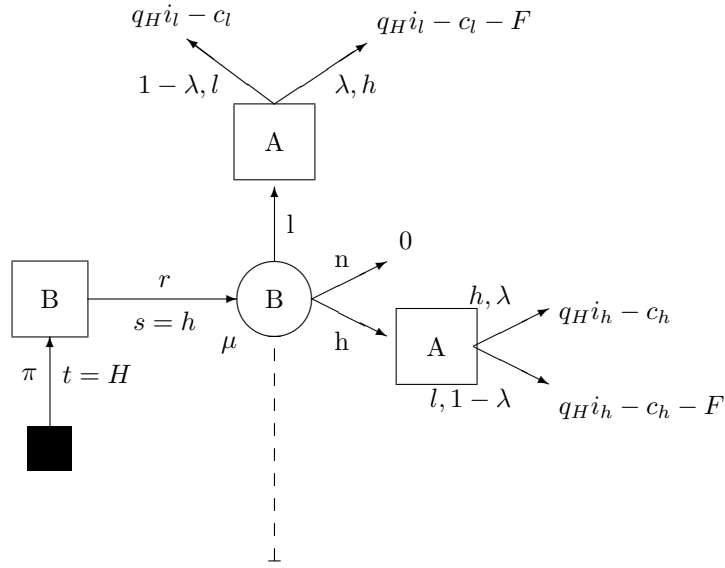
<sup>31</sup>Find the proof in the Appendix, page 20.

only if,

$$\frac{r}{w} > \frac{1 - \pi}{\pi} > \frac{1 - r}{1 - w}$$

Lemma 2.4 makes clear that the incentive effect of an authority with positive diagnosis skill also depends on the diagnosis skill of the supervised bank. A consequence of this lemma is that, even though the fine  $F$  cannot be made contingent on  $s$ , it is yet correlated: if the bank chooses  $d \neq s$ , then the fine is more likely than in case of  $d = s$ . Figure 6 shows only a part of the bank's decision tree under supervision: to keep matters simple, the exposition is limited to the case of  $s = h$  and  $t = H$ .

Figure 6: Internal rating with supervision



The decision tree again starts with the chance move (represented by the darkened box) that determines the credit applicant's type. If the Bank now decides to reject the customer, the tree ends. If, on the other hand, the bank gives credit (either  $d = h$  or  $d = l$ ), the authority A becomes active: if the bank has truthfully revealed its diagnosis signal, the authority confirms this decision with probability  $\lambda$ . However, with probability  $1 - \lambda$  the authority commits an error and imposes a fine. If the bank has deviated from its diagnosis result ( $d = l$ ),



the authority detects this cheating with probability  $\lambda$  and imposes a fine. An error (no fine) occurs with probability  $1 - \lambda$ .

The complete decision tree for internal rating under supervision can easily be developed by adding the supervising technology as outlined in figure 6 to any of the end nodes of figure 3 (except for those end nodes where  $d = n$ ). The main result of this section is summarized in the following proposition which is proven in the Appendix.<sup>32</sup>

**Proposition 4:** Given  $r, w, q_t, \pi, c_d, i_d, \lambda$  with  $d \in \{h; l; n\}, t \in \{H; L\}$ ,  $c_l > c_h$ ,  $i_l > i_h$ ,  $q_H > q_L$ , and  $r > \lambda > 1 - \lambda > w$ . Then, for a bank with internal rating and supervision, the reaction strategy (hl) is optimal only if  $F > 0$ .

A positive fine  $F > 0$  is a necessary (yet not sufficient) condition for the ability of an authority to provide the banks incentive to truthfully reveal its internal rating result. To put it differently: with  $F = 0$ , the bank will never have this incentive. Even though the authority has lesser diagnosis skill and screens only occasionally, a large enough fine may correct the bank's incentives. In this case, combinations of  $F$ ,  $c_h$  and  $c_l$  exist under which the bank chooses (hl), i.e. the truthful revelation of its internal rating results. Whereas the Basle Committee as well as KRAHNEN/WEBER (2001) propose monitoring and random inspections of internal ratings, neither explicitly mentions fines on allegedly wrong ratings. Without such, the bank has no incentive to truthfully reveal its diagnosis result by issuing a rating that equals the internal diagnosis result.

### 3 External rating

In the previous section it was shown that, if no fine is imposed, a bank has no incentives to truthfully reveal its internal rating results. Now consider an external rating agency which assigns a rating result to the potential credit customer and thereby determines his risk class. Denote the rating result of the external agency as  $x$ , with  $x \in \{h; l\}$ . If an applicant holding a rating  $x$  shows up in the bank, then the bank can only decide whether to grant credit at the conditions related to the rating (namely,  $c_x$  and  $i_x$ ), or to reject the customer. Hence, the bank's decision set depends on the assigned rating:  $d(x) \in \{x; n\}$ . Obviously, external rating separates the assignment of a risk class from the decision on credit conditions (or whether a credit is granted at all).

It is assumed that the rating agency has undistorted preferences, but imperfect diagnosis skill. Undistorted preferences means that the agency has nothing

<sup>32</sup>See page 21. The proof demonstrates that  $F$  not only needs to be positive, but is also required to be smaller than some upper limit. In principle, the conditions presented in the proof allow for the derivation of the lower and upper limits of values of  $F$  that implement (hl). However, such a quantitative assessment would go far beyond the scope of the simple model presented here.

to gain if it arbitrarily assigns a false rating. This assumption is especially justified if the rating agency has to maintain a reputation for good ratings when competing for potential customers.<sup>33</sup> It is fully acknowledged that banks may also have an interest in reputation, or that market forces may also cause them to take care of the quality of their ratings.<sup>34</sup> However, since the diagnosis results are private information, they will have difficulties in converting these results into public reputation.<sup>35</sup>

The intention of external rating agencies to maintain a reputation for good ratings, however, does not imply that their ratings are always correct. The imperfectness of diagnosis implies that the rating agency may commit errors when assigning a customer rating.<sup>36</sup> Let me denote the probabilities of a correct rating as

$$\phi = \Pr(x = h|t = H) = \Pr(x = l|t = L)$$

Hence, the probability of a wrong rating is

$$1 - \phi = \Pr(x = l|t = H) = \Pr(x = h|t = L)$$

with  $\phi > 1 - \phi$  (which implies  $\phi > 1/2$ ). Furthermore, it is assumed that the diagnosis skill of the external rating agency is not as good as the banks diagnosis skill:  $r > \phi > 1 - \phi > w$ . The bank's decision problem is visualized in figure 7.

The tree starts with a chance move, represented by the darkened box in the center, which determines the true but unknown type of the applicant. The rating agency (denoted as  $X$ ) then assigns a risk-class. Finally, the bank (again denoted as  $B$ ) makes its decision whether or not to grant a credit. The expected payoffs follow the model presented in the previous section.

Compared to the decision problem in figure 3, the bank here does not have the option of treating a customer contrary to the assigned risk-class. The bank thus has only four reaction strategies available, namely (nn), (hn), (nl), and (hl). The following proposition (which is easily proven by comparing the expected payoffs) shows that banks may have an incentive to act in accordance with the external rating, i.e. to choose the reaction strategy (hl).

**Proposition 5:** Given  $q_t, \pi, c_d, i_d$  with  $x \in \{l; h\}$ ,  $d \in \{x; n\}$ ,  $t \in \{H; L\}$ ,  $c_l > c_h$ ,  $i_l > i_h$ ,  $\phi > 1/2$ , and  $q_H > q_L$ . Then the bank chooses the reaction strategy (hl) if, and only if,

$$\begin{aligned} c_h &< i_h[\pi\phi q_H + (1 - \pi)(1 - \phi)q_L] \\ \wedge c_l &< i_l[\pi(1 - \phi)q_H + (1 - \pi)\phi q_L]. \end{aligned}$$

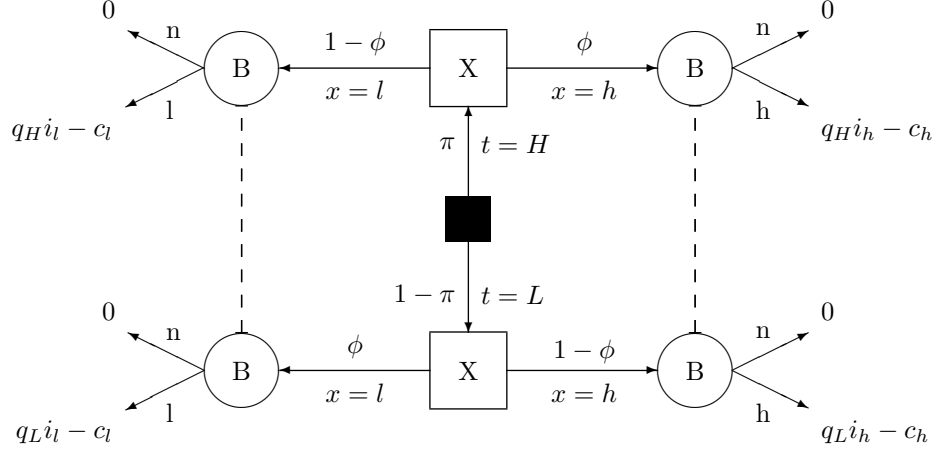
<sup>33</sup>For an analysis of the behavior of a monopolistic rating agency, see BOOM (1999).

<sup>34</sup>In such a situation self-regulation may even perform better than legal centralism. This is especially true if the equilibrium between competition jurisdictions consists of suboptimal regulation, as it is analyzed in VAN CAYSEELE/HEREMANS (1991).

<sup>35</sup>In the case of relationship banking, reputation arguments are not convincing anyway.

<sup>36</sup>It makes sense in this context to distinguish intended errors (due to flawed incentives) from unintended errors (caused by a lack of diagnosis skill).

Figure 7: Decision tree with external rating



The first of these two conditions implies that  $d = h$  is preferred to  $d = n$  if the external rating yields  $x = h$ , and the second condition implies that  $d = l$  is preferred to  $d = n$  if the external rating yields  $x = l$ . Since both conditions require that the credit costs be smaller than some positive value, it is obvious that combinations of  $c_l$  and  $c_h < c_l$  exist, such that both conditions hold.

## 4 Conclusion

The analysis has demonstrated that external ratings are better able than internal ratings to implement the goals of the Basle Committee's proposal. This is true even if the rating agency has detection skills for determining the true credit customer risk-type that are inferior, compared to the bank's. Internal rating, if not subject to supervision, will not implement the goals of the Basle Accord. Without supervision, banks have an incentive to assign a rating that deviates from the internal diagnosis result.

Banks are assumed to have better knowledge about their customers' risk-types than other actuors, such as external rating agencies or the authorities. Society

can only make use of this superior knowledge if the supervision authority is allowed to impose a fine on allegedly wrongful ratings. If the authority is not able to impose such a fine, but only may increase the equity ratio a bank has to obey (as proposed by the Basle Committee),<sup>37</sup> the necessary effect on the incentives of the bank will not be achieved.

There are examples of local regulation that provides for penalty schemes, such as the FDIC Improvement Act of 1991, according to which US banks that fail to comply with the equity requirements can be sanctioned.<sup>38</sup> However, these sanctions are not strictly linked to a divergence between the diagnosis result of the authority and the risk class announced by the bank. Without such an additional regulation, the Basle Accord is unlikely to reach its creators' goals. It therefore would make sense to amend the current proposal to make sure that supervision is not toothless in all countries where the Basle Accord is applied.

Note that the correction of the banks' incentives does neither require the diagnosis skill of the supervision authority to be superior or even perfect, nor that each case be examined. As long as the authority has positive diagnosis skill, imperfect diagnosis and occasional examinations can be sufficient to set the banks' incentives right. Such a mechanism is not yet provided for in the proposal of the Basle Committee.

Research concerning the Basle Accord should not only focus on the quality of rating systems, but also the incentives of those institutions that perform ratings and supervision. Diagnosis theory provides a useful tool for taking into account both incentives and diagnosis skill in a decision-model.

---

<sup>37</sup>See also DEUTSCHE BUNDESBANK (2001, 31).

<sup>38</sup>Experiences with the FDIC Improvement Act are analyzed by BENSTON/KAUFMAN (1997) and (1998).

## Appendix

### Proof of Lemma 1 on page 9:

Let me first show that  $r > w$  is equivalent to  $\mu > \nu$ . The Bayes formula yields

$$\mu = \frac{r\pi}{r\pi + w(1-\pi)}$$

and

$$\nu = \frac{(1-r)\pi}{(1-r)\pi + (1-w)(1-\pi)}$$

$\mu > \nu$  is thus equivalent to

$$\frac{r\pi}{r\pi + w(1-\pi)} > \frac{(1-r)\pi}{(1-r)\pi + (1-w)(1-\pi)}$$

$$\Leftrightarrow r\pi(1-w)(1-\pi) > w(1-\pi)(1-r)\pi$$

$$\Leftrightarrow r(1-w) > w(1-r)$$

which is equivalent to  $r > w$ : q.e.d.

It is then easy to show that  $r > w \wedge q_H > q_L$  is equivalent to  $\Theta(\mu) > \Theta(\nu)$ :

$$\Theta(\mu) > \Theta(\nu)$$

$$\Leftrightarrow \mu q_H + (1-\mu)q_L > \nu q_H + (1-\nu)q_L >$$

$$\Leftrightarrow (\mu - \nu)q_H > (\mu - \nu)q_L$$

Since  $r > w$  implies  $\mu > \nu$ , the last expression is equivalent to  $\Theta(\mu) > \Theta(\nu)$ : q.e.d.

### Proof of Lemma 2 on page 14:

Let me first consider the case that the bank has observed  $s = h$ . Then the probability of a fine is

$$\Pr(F|d = h) = r\pi\lambda + w(1-\pi)(1-\lambda)$$

if the bank chooses  $d = h$ , and

$$\Pr(F|d = l) = r\pi(1 - \lambda) + w(1 - \pi)\lambda$$

if it chooses  $d = l$ . The latter is greater than the former (and hence a fine is more likely when  $d \neq s$ ) if, and only if

$$w(1 - \pi)(1 - 2\lambda) > r\pi(1 - 2\lambda)$$

Recall that  $\lambda > 1/2$  is assumed. Hence, this yields

$$\frac{r}{w} > \frac{1 - \pi}{\pi}$$

In the same way it can be shown that, having observed  $s = l$ ,  $\Pr(F|d = h) > \Pr(F|d = l)$  if, and only if

$$\frac{1 - r}{1 - w} < \frac{1 - \pi}{\pi}$$

q.e.d.

### Proof of Proposition 4 on page 16:

If the bank has observed the diagnosis result  $s = H$ , then it prefers  $d = h$  to  $d = l$  iff

$$\mu[q_H i_h - c_h - (1 - \lambda)F] + (1 - \mu)[q_L i_h - c_h - \lambda F]$$

is greater than

$$\mu[q_H i_l - c_l - \lambda F] + (1 - \mu)[q_L i_l - c_l - (1 - \lambda)F]$$

Rearranging this condition yields

$$\Theta(\mu)i_h - c_h - [\mu(1 - \lambda) + (1 - \mu)\lambda]F > \Theta(\mu)i_l - c_l - [\mu\lambda + (1 - \mu)(1 - \lambda)]F$$

Recall that  $\Delta c = c_l - c_h > 0$ ,  $\Delta i = i_l - i_h > 0$ ,  $\mu > \nu$ , and  $\Theta(\mu) > \Theta(\nu)$ . The above condition is equivalent to

$$\Delta c > (1 - 2\mu)(2\lambda - 1)F + \Theta(\mu)\Delta i$$

Let me denote this condition as (4'), since it is equivalent to condition (4) in the model without fine, see Proposition 2:  $\Delta c > \Theta(\mu)\Delta i$ .

If, on the other hand, the bank has observed  $s = L$ , then it prefers  $d = l$  to  $d = h$  iff

$$\nu[q_H i_h - c_h - (1 - \lambda)F] + (1 - \nu)[q_L i_h - c_h - \lambda F]$$

is smaller than

$$\nu[q_H i_l - c_l - \lambda F] + (1 - \nu)[q_L i_l - c_l - (1 - \lambda)F]$$

Rearranging yields the condition (7'); compare this to condition (7) in Proposition 2:

$$\Delta c < (1 - 2\nu)(2\lambda - 1)F + \Theta(\nu)\Delta i$$

For the reaction strategy (hl) to be optimal, (4') and (7') are necessary (not sufficient) conditions. (4') and (7') is equivalent to

$$(1 - 2\nu)(2\lambda - 1)F + \Theta(\nu)\Delta i > \Delta c > (1 - 2\mu)(2\lambda - 1)F + \Theta(\mu)\Delta i$$

This expression would allow the derivation of an the upper and the lower limit of the values of  $F$  that implement the reaction strategy (hl). However, such a quantitative claim is beyond the scope of this simple model. Hence, the focus is limited here to the following qualitative result. (4) and (7) imply

$$(1 - 2\nu)(2\lambda - 1)F + \Theta(\nu)\Delta i > (1 - 2\mu)(2\lambda - 1)F + \Theta(\mu)\Delta i$$

Solving for  $F$  yields

$$(2\lambda - 1)(1 - 2\nu - 1 + 2\mu)F > [\Theta(\mu) - \Theta(\nu)]\Delta i$$

Recall that  $\mu > \nu$  and  $\lambda > 1/2$ , hence the last expression is equivalent to

$$F > \frac{[\Theta(\mu) - \Theta(\nu)]\Delta i}{2(\mu - \nu)(2\lambda - 1)}$$

The right hand side is positive, hence it is proven that  $F > 0$  is a necessary condition for (hl) being an optimal reaction strategy: q.e.d.

## References

- Altman, E.I./Saunders, A. 2001:** An Analysis and Critique of the BIS Proposal on Capital Adequacy and Ratings; in: *Journal of Banking and Finance* 25 (1), 25-46.
- Basle Committee 1999:** Capital Requirement and Bank Behavior: The Impact of the Basle Accord; Working Paper prepared for the International Conference on Financing for Development (Mexico 2002), April 1999, Basle (downloaded on May 18, 2001, from <http://esa.un.org/ffd/policydb/PolicyTextx/bis-3.htm>).
- Benston, G.J./Kaufman, G.G. 1997:** FDICIA After Five Years; in: *Journal of Economic Perspectives*, 139-158.
- Benston, G.J./Kaufman, G.G. 1998:** Deposit Insurance Reform in the FDIC Improvement Act: The Experience to Date; in: *Federal Reserve Bank of Chicago, Economic Perspectives* 22(2).
- Blattner, N. 1995:** Capital Adequacy Rules as Instruments for the Regulation of Banks; in: *Swiss Journal of Economics and Statistics* 131 (4/2), 719-721.
- Blattner, N. 1996:** Capital Adequacy Regulation: There is Hardly an Alternative; in: *Swiss Journal of Economics and Statistics* 132 (4/2).
- Blum, J. 1999:** Do Capital Adequacy Requirements Reduce Risks in Banking? in: *Journal of Banking and Finance* 23, 755-771.
- Börsen-Zeitung 1999:** Meister: Internes Rating für breiten Bankenkreis. Teilanwendung des Ratingverfahrens als Einstieg. Vorschläge für Mindeststandards in Arbeit; in: *Börsen-Zeitung*, 3. Dec.99, cit. Deutsche Bundesbank, Auszüge aus Presseartikeln 74, 3. Dec. 99, 13.
- Boom, A. 1999:** A Monopolistic Credit Rating Agency; unpublished mimeo, Berlin.
- Broecker, T. 1990:** Credit-Worthiness Tests and Interbank Competition; in: *Econometrica* 58 (2), 429-452.
- Cao, M./Shouyong, S. 1999:** Screening, Bidding, and the Loan Market Tightness; Queen's University, Institute for Economic Research Discussion Paper 98, Kingston, Ontario.
- Covitz, D.M./Heitfield, E.A. 1999:** Monitoring, Moral Hazard, and Market Power: A Model of Bank Lending; Federal Reserve Board, Finance and Economics Discussion Series, 1999-37.



- Dell’Ariccia, G. 2000:** Learning by Lending, Competition, and Screening Incentives in the Banking Industry; Paper presented at the Conference “Competition among Banks”, Center for Financial Studies, 7./8. April, Frankfurt/M.
- Deutsche Bundesbank 2001:** Die neue Baseler Eigenkapitalvereinbarung (Basel II); in: Monatsbericht April, Frankfurt/M., 15-44.
- Economist 1999:** Basle bust-up; in: The Economist 16th October 1999, 100.
- FAZ 2000:** Selbst viele Großunternehmen haben noch kein Rating; in: Frankfurter Allgemeine Zeitung No. 270, 20. Nov. 00, 23.
- Feess, E./Schieble, W. 1999:** Credit Scoring and Incentives for Loan for Loan Officers in a Principal Agent Model; Johann-Wolfgang Goethe Universität, Working Paper Series Finance and Accounting No. 30, Frankfurt/Main.
- Gehrig, T. 1995:** Capital Adequacy Rules: Implications for Banks’ Risk-Taking; in: Swiss Journal of Economics and Statistics 131 (4/2), 747-764.
- Green, D./Swets, J. 1966:** Signal Detection Theory and Psychophysics; New York.
- Hauswald, R./Marquez, R. 2000:** Relationship Banking, Loan Specialization, and Competition; Paper presented at the Conference “Competition among Banks”, Center for Financial Studies, 7./8. April, Frankfurt/M.
- Heiner, R.A. 1983:** The Origin of Predictable Behavior; American Economic Review 73, 560-595.
- Heiner, R. A. 1986:** Uncertainty, Signal-Detection Experiments, and Modeling Behavior; in: LANGLOIS (ED.): Economics as a Process. Essays in the New Institutional Economics; Cambridge, MA et. al., 59-115.
- Heiner, R. A. 1990:** Imperfect Choice and the Origin of Institutional Rules; in: Journal of Institutional and Theoretical Economics 146 (4), 720-726.
- Hellwig, M. 1995:** Systemic Aspects of Risk Management in Banking and Finance; in: Swiss Journal of Economics and Statistics 131 (4/2), 723-737.
- Kirstein, R./Neunzig, A.R. 1999:** A Note on Credit Worthiness Tests; Center for the Study of Law and Economics, Discussion Paper 9903, Saarbrücken.
- Kirstein, R./Schmidtchen, D. 1997:** Judicial Detection Skill and Contractual Compliance; in: International Review of Law and Economics 17 (4), 509-520.

- Krahnen, J.P./Weber, M. 2001:** Generally Accepted Rating Principles: A Primer; in: Journal of Banking and Finance 25 (1), 3-23.
- Machauer, A./Weber, M. 1998:** Bank behavior based on internal credit ratings of borrowers; in: Journal of Banking and Finance 22, 1355-1383.
- Meister, E. 2000:** Entwicklungslinien und Perspektiven der (inter)nationalen Bankenaufsicht; Vortrag beim 1. Norddeutschen Bankentag, June 13th, Lüneburg, cit. Deutsche Bundesbank, Auszüge aus Presseartikeln 28, 15.6.2000, 1-6
- Meister, E. 2001:** Die Sorgen des Mittelstands haben Vorrang. Edgar Meister vom Direktorium der Deutschen Bundesbank zur Verschiebung von Basel II; in: Frankfurter Allgemeine Zeitung No. 145, 26. June 01, 19
- Santos, J.A.C. 2000:** Bank Capital Regulation in Contemporary Banking Theory: A Review of the Literature; Bank for International Settlements Working Paper 90, Basle
- Sheldon, G. 1996a:** Capital Adequacy Rules and the Risk-Seeking Behavior of Banks: A Firm-Level Analysis; in: Swiss Journal of Economics and Statistics 132 (4/2), 709-734
- Sheldon, G. 1996b:** Capital Asset Ratios and Bank Default Probabilities: An International Comparision Based on Accounting Data; in: Swiss Journal of Economics and Statistics 132 (4/2), 743-754
- Steltzner, H. 1999:** Kampf um Kreditkosten. Der Basler Akkord; in: Frankfurter Allgemeine Zeitung 240, 15. Oct. 99, 13
- van Cayseele, P./ Heermans, D. 1991:** Legal Principles of Financial Market Integration in 1992: An Economic Analysis; in: International Review of Law and Economics 11, 83-99