

## **Bank Risk, Regulation and Financial Futures Policy**

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### **Abstract**

Recent experience with the misuse of financial futures by banks (e.g., the Barings bank case) seems to support regulational acts which constrain the bank's volume of risky financial derivatives. The paper presents two models of a bank's risk policy in financial futures, both for the case of imperfect and perfect information. In the first model, the manager-owners' policy is governed by moral hazard w.r.t. the bank's futures risk (asset substitution problem). In the second model, a risk-averse bank facing interest rate risk optimizes its maturity transformation gap and its futures hedging volume simultaneously. Under moral hazard, the impact of futures regulation on the optimal policies proves to be ambiguous, while regulation effects are unambiguously negative under perfect information.

### **Résumé**

Les expériences récentes en matière d'emploi abusif d'actifs à terme par les banques, comme l'atteste l'exemple de la banque Barings, semblent justifier la mise en œuvre de mesures de régulation visant à limiter le volume de produits dérivés risqués détenus par les banques. L'article présente deux modèles de politique financière relative à ce type d'actifs, sous hypothèse d'information imparfaite, puis d'information parfaite. Dans le premier modèle, la formulation de la politique élaborée par le dirigeant, qui est aussi le propriétaire, rencontre une situation de hasard moral. Le problème qui se pose est celui de la substitution des titres. Dans le deuxième modèle, une banque averse au risque qui fait face à un risque de taux d'intérêt optimise simultanément la maturité de son portefeuille et la couverture des actifs à terme risqués. Sous moral hazard la régulation de l'utilisation des titres se montre d'être ambiguë, pendant la régulation sous hypothèse d'information parfaite a des effets unambigus négatifs.

### **Keywords**

Bank risk, financial futures, regulation, moral hazard, maturity transformation.

## 1. Introduction

Depository institutions like commercial banks, savings banks and credit unions - we call them *banks* for short in the following - constitute an important part of the financial sector in modern economies. Banks perform numerous financial services and intermediation functions as, e.g., supply of perfectly liquid investments or arbitrarily sized loan volumes, risk sharing, and maturity transformation. Originating to these intermediation services, banks face various kinds of risk like credit risk, interest rate risk or exchange rate risk (Gardner/Mills (1988)). Owing to the significance of the financial sector with respect to the performance of highly developed economic systems, major bank crises are usually accompanied by a considerable public attention. The German Herstatt case as well as some recent crises in US-thrift institutions and agricultural banks are well-known examples. As a response to the endangering impact of a massive risk-induced bank default on the production sector of modern economies, the risk policy of depository institutions is commonly constrained by regulatory acts as, e.g., the obligatory fixed-rate deposit insurance scheme in US-banks (Ronn/Verma (1986), Merton (1977)), or the German Kreditwesengesetz together with the Grundsätze I to III and its diverse supplementary laws in the sequel of the European unification process (e.g. Boos/Höfer (1995a, b), Schulte/Mattler (1994a), Rudolph (1995)). An extensive literature discusses both practical and theoretical facets of regulation in the financial sector.<sup>1</sup>

In the more recent past, the increasing utilization of financial derivatives in banks directed the public attention towards the risk potential of financial futures, options and swaps. On the one hand, and perfectly demonstrated by the Barings bank bankruptcy case, the leverage effects embodied in the use of financial derivatives constitutes a considerable danger to uninformed customers and depositors, if the bank managers' behaviour is characterized by moral hazard. Regulation of derivatives thus appears as a meaningful task of regulatory authorities if banks operate in credit markets with imperfect information. An unnecessarily restrictive regulation of derivatives, on the

other hand, restrains their use as an effective hedging instrument if a benevolent management acts under the primacy of perfect information and risk aversion. The resulting trade-off has to be taken into account when financial derivatives are subject to regulation.

The purpose of this paper is to analyze how futures regulation affects a bank's *risk policy*, both under perfect and imperfect information. In the case of imperfect information and limited liability (see section 2), the bank's manager-owners face an incentive to switch to risky futures policies (2.1), which harms the position of the uninformed depositors (asset substitution problem). In the context of a simple model of the asset substitution problem (2.2), the possible impact of two basic regulation schemes on the optimal risk policy under moral hazard is analyzed analytically (2.3). In the case of perfect information (see section 3), we focus on the prospective positive role of financial futures in both the hedging decisions and the production process of a risk-averse bank facing interest rate risk (3.1). The two-period model presented in 3.2 allows to copy the optimal maturity transformation function of the bank together with its optimal futures hedging volume. The possible effects of regulation are evaluated by a comparative static analysis of the simultaneous optimum of the bank in the asset and the futures market (3.3). Section 4 concludes the paper.

## **2. Financial Futures Regulation under Asymmetric Information**

### **2.1 Preliminaries**

A major motive of bank regulation are possible incentives of financial institutions to increase their risk. As an example, the 'profit center' organization of many large banks provides a natural tendency to hedge each department's risk from a micro perspective (Saunders (1987)). Unfortunately, these micro hedges when aggregated may actually work to increase a bank's risk exposure. While this increase in risk happens unvoluntarily, and due to organizational conditions, we focus on the classical risk

incentive of manager-owners under the financial conditions of limited liability and asymmetric information. If the bank's investment policy cannot be perfectly controlled by the depositors due to asymmetric information, bank owners *voluntarily* switch to riskier policies according to the convexity of their option-like pay-off function (Merton (1973), Galai/Masulis (1976)). In the corporate finance literature, several contractual designs as, for example, the use of collateral (Bester (1987)) or the issuance of warrants (Green (1984)), have been propounded as incentive compatible designs to solve the risk incentive problem (for a critique, see Kürsten (1994)). In the banking literature, a similar risk incentive induced by the option-like pay-off function of fixed-rate deposit insurance provoked an extensive discussion around the introduction of variable-rate deposit insurance schemes (Merton (1977), Ronn/Verma (1986), Chan/Greenbaum/Thakor (1992)). In the following, the classical risk incentive problem serves as an example of a possible opportunistic risk policy in financial institutions. Especially, and due to the incorporated leverage effect, financial futures are regarded as "convenient" instruments to perform that policy.

## 2.2 A Model of Banks Risk Incentive

Following a model of Green/Talmor (1986), we denote the stochastic end-of-period cash flow of the bank as

$$(1) \quad Y(\Theta) = \mu(\Theta) + \sigma(\Theta) \cdot \varepsilon \quad \begin{array}{l} (E(\varepsilon) = 0, \mu'(\Theta) \leq 0, \sigma'(\Theta) > 0, \\ \Theta \in [0,1]), \end{array}$$

where a greater risk  $\Theta$  induces both a higher variance  $\sigma^2(\Theta) \cdot \text{var}(\varepsilon)$  and a lower expected value  $\mu(\Theta)$  of the bank's cash flow  $Y$  ("mixed" risk incentive problem). In the case  $\mu'(\Theta) = 0$ , the expected cash flow remains constant ("pure" risk incentive problem).<sup>2</sup> As is common in the relevant literature (Green/Talmor (1986), Gavish/Kalay (1983)), we assume that all stakeholders are risk-neutral, maximizing the risk-free discounted expected value (market value)<sup>3</sup> of their individual claims. If the

Pareto-optimal investment policy  $\Theta_0 = 0$  stipulated by contract cannot be enforced by depositors, the manager-owner of a bank financed with risky debt switches to his optimal project  $\Theta^*$  (moral hazard)

$$(2) \quad \Theta^* = \arg \max_{\Theta \in [0,1]} E(s \cdot \max\{Y(\Theta) - D, 0\}) \geq \Theta_0,$$

where  $s \in (0,1]$  denotes the manager-owner's share in the total equity, and  $D$  is the debt obligation promised to depositors. The optimal interior solution  $\Theta^* \in (0,1)$  of the mixed risk incentive problem ( $\mu' < 0$ ) is characterized by the first-order condition<sup>4</sup>

$$(3) \quad \begin{aligned} \frac{\partial}{\partial \Theta} E(s \cdot \max\{Y(\Theta) - D, 0\}) \\ = s \cdot (1 - F(\hat{\varepsilon}(\Theta))) \cdot [\mu'(\Theta) + \sigma'(\Theta) \cdot E(\varepsilon | \varepsilon \geq \hat{\varepsilon}(\Theta))] \\ = 0 \quad \quad \quad \text{with } \hat{\varepsilon}(\Theta) := (Y(\Theta) - \mu(\Theta)) / \sigma(\Theta), \end{aligned}$$

while the optimum of the pure risk incentive problem ( $\mu' = 0$ ) is always the riskiest available project,  $\Theta^* = 1$ , since the derivative (3) is positive for all  $\Theta \in [0,1]$  in this case.

### 2.3 Effects of Financial Futures Regulation

According to the leverage effect embodied in the usual margin schemes of clearing houses (Hull (1993), pp. 22), financial futures contracts are a "suitable" means to increase a bank's risk via moral hazard of its manger-owners. Thus, as an adequate example of the risk incentive, in the following we interpret the parameter  $\Theta$  from the last section as the volume of the (net) position of financial futures in the bank portfolio.<sup>5</sup> Futures regulation can be achieved by either (a) restricting the maximum futures position  $\Theta$  to a limited range  $\Theta \in [0, \kappa]$  (direct regulation), or (b) imposing an additional cost  $c(\Theta)$  ( $c'(\Theta) \geq 0$ ) on every futures engagement  $\Theta$  (indirect

regulation). In the German "Kreditwesengesetz", for example, method (a) has been implemented via the former "Grundsatz Ia" in its 1990 novellized form, which requires that the net futures position remains limited to a certain percentage of the bank's total equity<sup>6</sup>. Similarly, the method (b) is condensed in the Grundsatz I which requires that a (default-) risk specific percentage of every open futures position is charged to the bank's equity account. Additional capital-reserve requirements are directed by the 1995 novellized Grundsatz Ia in the sequel of transforming the European "Kapitaladäquanzrichtlinie" into German regulatory law (Schulte/Mattler (1994a)). Since the corresponding adequacy requirements of equity cannot be used as an underlying for other bank activities (e.g., a loan contract), the present Grundsätze I and II impose an additional (opportunity) cost on a bank's use of derivatives.<sup>7</sup>

How do both kinds of regulation affect the moral hazard-induced misuse of financial futures by the bank's manager-owner? Concerning direct regulation, excessive risk taking is limited if the exogenous threshold  $\kappa$  falls below the optimal position  $\Theta^*$ ,  $\kappa < \Theta^*$ . In the case  $\kappa \geq \Theta^*$ , regulation does not constrain the manager-owner's risk incentive. Since, at least principally, financial institutions can engage in futures to an unlimited extent, the introduction of some regulation threshold  $\kappa$  should promise positive risk effects. Of course, such positive risk effects must be balanced against possible negative risk effects if financial futures can only be used on a reduced level to hedge the bank's interest rate risk (see section 3). Concerning indirect regulation, the impact of some additional cost  $c(\Theta)$  on a bank's risk policy follows from a comparative static analysis of its optimal risk  $\Theta^*$  as given by (2). For the ease of demonstration, let the cost term be linear in  $\Theta$ ,  $c(\Theta) = c \cdot \Theta$  ( $c > 0$ ). Incorporating the regulation costs in the terminal cash flow (1)

$$(4) \quad Y(\Theta, c) = \mu(\Theta) + \sigma(\Theta) \cdot \varepsilon - c \cdot \Theta$$

yields the first-order condition

$$\begin{aligned}
 & \frac{\partial}{\partial \Theta} E(s \cdot \max\{Y(\Theta, c) - D, 0\}) \\
 (5) \quad & = s \cdot (1 - F(\hat{\varepsilon}(\Theta, c))) \cdot [\mu'(\Theta) - c + \sigma'(\Theta) \cdot E(\varepsilon | \varepsilon \geq \hat{\varepsilon}(\Theta, c))] \\
 & = 0 \quad , \text{ with } \hat{\varepsilon}(\Theta, c) = (Y(\Theta, c) - \mu(\Theta) + c \cdot \Theta) / \sigma(\Theta).
 \end{aligned}$$

In the case of the pure risk incentive problem ( $\mu' = 0$ ), (5) prescribes the border value  $\Theta^* = 1$  to be optimal if the slope of the cost function is "small" ( $c < \sigma'(\Theta) \cdot E(\varepsilon | \varepsilon \geq \hat{\varepsilon}(\Theta, c))$ ) for all  $\Theta \in [0, 1]$ . Then, marginally increasing the regulation costs  $c$  has no impact on the manager-owner's risk policy, i.e., a tighter regulation scheme exhibits no positive incentive effects. If the marginal costs are "big" ( $c > \sigma'(\Theta) \cdot E(\varepsilon | \varepsilon \geq \hat{\varepsilon}(\Theta, c))$ ) for all  $\Theta \in [0, 1]$ , the high risk project  $\Theta^* = 1$  previously optimal without regulation (see (3)) is replaced by the low risk optimum  $\Theta^* = 0$ , i.e., the introduction of indirect regulation eliminates the bank's risk incentive problem and restores the Pareto-optimum. Finally, with "intermediate" regulation costs or in the case of the mixed risk incentive problem ( $c - \mu'(\Theta^*) = \sigma'(\Theta^*) \cdot E(\varepsilon | \varepsilon \geq \hat{\varepsilon}(\Theta^*, c))$ ) for some  $\Theta^* \in (0, 1)$ , the impact of a marginal cost increase on the resulting interior optimum  $\Theta^* \in (0, 1)$  can be evaluated by differentiating (5) implicitly<sup>8</sup>

$$(6) \quad \frac{\partial \Theta^*}{\partial c} = - \frac{E(\max\{Y(\Theta, c) - D, 0\})_{\Theta c}}{E(\max\{Y(\Theta, c) - D, 0\})_{\Theta \Theta}} \Big|_{\Theta = \Theta^*} .$$

By inspection of the crucial cross derivative

$$\begin{aligned}
 \text{sign } \frac{\partial \Theta^*}{\partial c} &= \text{sign } E(\max\{Y(\Theta, c) - D, 0\})_{\Theta=c|\Theta=\Theta^*} \\
 (7) \qquad &= \text{sign } \left\{ \sigma'(\Theta) \cdot \frac{f(\hat{\varepsilon}) \cdot \Theta}{\sigma(\Theta)} \cdot [E(\varepsilon|\varepsilon \geq \hat{\varepsilon}) - \hat{\varepsilon}] - (1 - F(\hat{\varepsilon})) \right\}_{|\Theta=\Theta^*} \\
 &\geq 0,
 \end{aligned}$$

the results are ambiguous: Owing to the positivity of the two terms in (7), their difference may take any sign. For example, the derivative  $\frac{\partial \Theta^*}{\partial c}$  is negative if the sensitivity of the variance  $\sigma(\Theta)$  with respect to  $\Theta$  is low ( $\sigma' \approx 0$ ), while a high sensitivity  $\sigma$  results in a positive derivative. In the former case, enforcing the regulation requirements  $c$  mitigates the manager-owner's risk incentive, i.e., regulation is incentive compatible. In the latter case, regulation enforces the manager-owner's risk incentive, is incentive *incompatible*. In summary, imposing additional costs on a intermediary's financial futures policy may *both ameliorate and aggravate* possible risk incentive problems under moral hazard.<sup>9</sup>

### 3. Financial Futures Regulation under Symmetric Information

#### 3.1. Preliminaries

As opposed to the model developed in 2.1, in this section we focus on the paradigm of a benevolent, risk-averse bank which uses financial futures to hedge its interest rate risk. A major source of interest rate risk is the transformation of variable-rate, short term liabilities (e.g., deposits) into fixed-rate, long term assets (e.g., loans) (Jaffee (1986), Kürsten (1991, 1993), Santomero (1983)). While maturity transformation provides the bank with a positive net interest rate margin when the yield curve is normal, the resulting *positive maturity gap* in its balance sheet - the volume of fixed-rate assets exceeds that of fixed-rate liabilities - exposes the bank to the risk of rising interest rates. The prevailing view in the literature of financial futures hedging focusses on the optimal futures volume with the balance sheet gap as given (Ederington (1979),

Koppenhaver (1985), Veit/Reiff (1983)). The usual approach denies the fact that a risk-reducing futures engagement itself exhibits some reaction on the gap if the gap-futures-position is optimized *simultaneously*. As has been shown by Kürsten (1991, 1993), the possibility to engage in futures contracts not only reduces the bank's risk exposure, but also allows (and forces) the bank to enlarge its transformation gap ("real production effect" of futures) which implies higher bank profits from maturity transformation. In the following we analyze how the situation is affected if a regulator imposes additional costs on the use of futures contracts.

### 3.2. A Model of Bank Maturity Transformation

The bank faces a given total demand for two-period loans. In  $t = 0$ , borrowers use these funds to finance a two period investment whose cash flow is realized at the end of period two ( $t = 2$ ). A portion  $\alpha$  (or  $\beta$ , resp.) of total bank loans (or liabilities, resp.) consists of roll-over (short term) one-period contracts, the remaining part  $1 - \alpha$  (or  $1 - \beta$ , resp.) consists of (long term) two period contracts. All interest plus principal is paid in  $t = 2$ . Long term loans (or liabilities, resp.) yield the (squared) two-period spot rate  $R_2^A = (1 + r_2^A)$  (or  $R_2^L = 1 + r_2^L$ , resp.). Short term loans (or liabilities, resp.) yield the one-period spot rate  $R_1^A = 1 + r_1^A$  (or  $R_1^L = 1 + r_1^L$ , resp.) times the one-period spot rate  $\tilde{R}_1^A$  (or  $\tilde{R}_1^L$ , resp.) which prevails at the end of period one ( $t = 1$ ). Let  $R_1^A = R_1^L =: R_1$  and  $R_2^A = R_2^L =: R_2$  for the sake of simplicity.<sup>10</sup> From the  $t = 0$  point of view, where all bank decisions are made,  $\tilde{R}_1^A$  and  $\tilde{R}_1^L$  are random. A possibly non-perfect correlation between asset rate and liability rate describes *basic risk*, i.e., the correlation coefficient  $\text{corr}(\tilde{R}_1^A, \tilde{R}_1^L) =: \gamma < 1$ . The presence of some *elasticity risk* is excluded to simplify calculations, i.e.,

$\text{Var}(\tilde{R}_1^A) = \text{Var}(\tilde{R}_1^L)$  by assumption. As the third component of interest rate risk, there may be some *fixed-rate risk* if the balance sheet gap is non-zero,  $\beta - \alpha \neq 0$ .<sup>11</sup>

The monetary objective of the bank is its equity at the end of period two. As is common in the relevant literature, we do not consider any systematic correlation effects with the bank's remaining activities (Wilhelm (1982)). The final monetary objective is thus given by the profit

$$(8) \quad \pi = (\alpha \tilde{R}_1^A - \beta \tilde{R}_1^L) \cdot R_1 + [(1-\alpha) - (1-\beta)] \cdot R_2^2.$$

The bank is risk averse (Edwards (1977), Ratti (1980)) and uses the preference functional  $\text{EU}(\cdot) = \text{E}(\cdot) - \frac{\lambda}{2} \cdot \text{Var}(\cdot)$  ( $\lambda = \text{absolute risk aversion}$ ) to calculate its optimal short term asset portion  $\alpha^*$

$$(9) \quad \alpha^* = \arg \max_{\alpha \in [0,1]} \text{E}(\pi(\alpha)) - \frac{\lambda}{2} \text{Var}(\pi(\alpha)).$$

We thus follow the traditional asset management approach which regards the liability side of a bank's balance sheet as market determined, while on the asset side the bank retains some discretionary control. Differentiation of the concave objective function (9) yields the optimum

$$(10) \quad \alpha^* = \frac{\text{E}(\tilde{R}_1^A - {}_0R_{1,2})}{\lambda \cdot R_1 \cdot \text{Var}(\tilde{R}_1^A)} + \gamma \cdot \beta,$$

where  ${}_0R_{1,2} = R_2^2 / R_1$  denotes the implied forward rate. Ceteris paribus, a speculative oriented bank ( $\lambda < \infty$ ) prefers a greater (smaller) portion of its loan volume to consist of roll-over contracts if spot rates are expected to rise (fall). If the bank management is

extremely risk averse ( $\lambda \rightarrow \infty$ ) or follows the expectation hypothesis of interest rates ( $E(\tilde{R}_1^A) = {}_0R_{1,2}$ ), the variance minimizing solution requires

$$(11) \quad \alpha^* = \gamma \beta < \beta,$$

i.e., the bank's optimal balance sheet gap is non-zero and positive,  $\beta - \alpha^* > 0$ . The bank performs some *positive* maturity transformation since the volume of long term assets exceeds that of long term liabilities,  $1 - \alpha^* > 1 - \beta$ . The positive gap results from an optimal trade-off between isolated fixed rate risk which is minimal if the gap is zero,  $\beta - \alpha = 0$ , and isolated basis risk which is minimal if there are no short term loans,  $\alpha = 0$ . Note that the non-zero gap (11) results as an optimal *response* to the presence of interest rate risk, while in the literature the gap is usually interpreted as a main *source* of interest rate risk (e.g., Gardner/Mills (1988)).

### 3.3 Effects of Financial Futures Regulation

Financial futures are now incorporated in the model as a hedging device. In  $t = 0$ , the bank enters a delivery date  $T \geq 1$  futures contract at a futures rate  $R_f$  which is offset in  $t = 1$  at a futures rate  $\tilde{R}_f$ . The corresponding futures prices are  $1 - R_f$  or  $1 - \tilde{R}_f$ , respectively. The futures rate  $\tilde{R}_f$  is random from the  $t = 0$  point of view, and induces an additional basis risk by its possibly non-perfect correlation with the future spot rates,  $\tilde{R}_1^A$  or  $\tilde{R}_1^L$ . To simplify the presentation, we assume  $\text{Var}(\tilde{R}_1^A) = \text{Var}(\tilde{R}_1^L) = \text{Var}(\tilde{R}_f)$  and  $\text{corr}(\tilde{R}_1^A, \tilde{R}_f) = \text{corr}(\tilde{R}_1^L, \tilde{R}_f) = : \delta$ .<sup>12</sup> As is common in futures hedging models (e.g., Koppenhaver (1985b)), we refrain from margin requirements and treat any futures profits or losses as realized in  $t = 2$ . The intermediary's profit with a futures volume of  $\Theta$  is given by

$$(12) \quad \pi_f(\alpha, \Theta) = \pi(\alpha) + \Theta \cdot ((1 - \tilde{R}_f) - (1 - R_f))$$

where  $\Theta < 0$  ( $\Theta > 0$ ) indicates a short (long) position in the futures market. The simultaneous optimum of the bank with respect to both the asset variable  $\alpha \in [0,1]$  and the futures volume  $\Theta \in \mathbb{R}$  is determined by the linear equation system

$$(13) \quad (\alpha^{**}, \Theta^{**}) = \arg \max_{\substack{\alpha \in [0,1] \\ \Theta \in \mathbb{R}}} E(\pi_f(\alpha, \Theta)) - \frac{\lambda}{2} \cdot \text{Var}(\pi_f(\alpha, \Theta)).$$

Solving (13) yields

$$(14a) \quad \alpha^{**} = \frac{E(\tilde{R}_1^A - {}_0R_{1,2}) + \delta \cdot E(R_f - \tilde{R}_f)}{\lambda R_1 \text{Var}(\tilde{R}_1) \cdot (1 - \delta^2)} + \beta \cdot \frac{\gamma - \delta^2}{1 - \delta^2}$$

$$(14b) \quad \Theta^{**} = \frac{\delta \cdot E(\tilde{R}_1^A - {}_0R_{1,2}) + E(R_f - \tilde{R}_f)}{\lambda \text{Var}(\tilde{R}_1) \cdot (1 - \delta^2)} + R_1 \cdot \beta \delta \cdot \frac{\gamma - 1}{1 - \delta^2}$$

as the general solution for the case of non-perfect hedging,  $\delta \neq \pm 1$ .<sup>13</sup> As an example, if martingale efficiency is assumed to hold for both implied forward rates and futures rates (in arbitrage-free markets this requires caution, see Wilhelm (1985)), or if the bank is extremely risk averse ( $\lambda \rightarrow \infty$ ), the relevant case of a positive correlation between the spot rate and the futures rates ( $\text{corr}(\tilde{R}_1, \tilde{R}_f) = \delta > 0$ ) requires a short position in the futures market,  $\Theta^{**} < 0$  (note that  $\gamma < 1$  due to basis risk). Further, the optimal asset position with futures hedging  $\alpha^{**}$  (see the second term in (14a)) falls below the optimal asset position without futures hedging  $\alpha^*$  (see (11)). As a result,

$$(15) \quad \beta - \alpha^{**} = \beta \cdot \left(1 - \frac{\gamma - \delta^2}{1 - \delta^2}\right) > \beta \cdot (1 - \gamma) = \beta - \alpha^*,$$

i.e., the possibility to engage in financial futures *enlarges* the bank's balance sheet gap, which induces higher profits for the bank if the yield curve is normal. This real production effect is due to the fact that the hedging potential of futures allows (and forces) the bank to accept a higher interest rate risk from its maturity transformation to reach the global risk optimum in (13). As another result, the corresponding futures position in the simultaneous optimum can easily be seen to exceed the sequentially optimized futures volume which takes the asset position  $\alpha^*$  from (11) as given,  $|\Theta^{**}| > |\Theta^*(\alpha^*)|$ . Unfortunately, the latter (suboptimal) procedure is commonly adopted in the literature (Koppenhaver (1985a,b, 1990), Morgan/Shome/Smith (1988)).

The impact of financial futures regulation on the simultaneous bank optimum (14) can now be analyzed. In the case of direct regulation, restricting the futures volume by an upper bound  $\kappa$  increases total bank risk if  $\kappa$  restrains the global futures optimum,  $\kappa < |\Theta^{**}|$ . Consequently, the asset optimum under the regulation constraint  $|\Theta| \leq \kappa$  falls below the global optimum  $\alpha^{**}$ , which leaves the bank with reduced maturity transformation profits. In the case of indirect regulation, imposing additional costs  $c$  on the use of futures contracts affects the bank's profit function (12). If the usual positive correlation between the spot rate  $\tilde{R}_t^A$  and the futures rate  $\tilde{R}_t^f$  obtains ( $\delta > 0$ ) and the expectation term is not "too big",<sup>14</sup> the futures position is short and the profit function under regulation can be denoted as

$$(16) \quad \pi_{f,reg}(\alpha, \Theta) = \pi_f(\alpha, \Theta) + c \cdot \Theta \quad (c > 0).$$

The simultaneous asset-futures-optimum under regulation of a bank which is short in the futures market is calculated from (13), where the profit function  $\pi_f$  is replaced by the modified profit function  $\pi_{f,reg}$  to yield

$$(17a) \quad \alpha_{reg}^{**} = \alpha^{**} + \frac{c}{\lambda R_1 \text{Var}(\tilde{R}_1) \cdot (1 - \delta^2)} \quad (\delta \neq \pm 1)$$

$$(17b) \quad \Theta_{reg}^{**} = \Theta^{**} + \frac{c}{\lambda \text{Var}(\tilde{R}_1) \cdot (1 - \delta^2)} .$$

If the bank is extremely risk averse ( $\lambda \rightarrow \infty$ ), regulation costs will not affect the global bank optimum,  $(\alpha^{**}, \Theta^{**}) = (\alpha_{reg}^{**}, \Theta_{reg}^{**})$ . If the bank shows some speculative behaviour ( $\lambda < \infty$ ), the regulation costs will unambiguously increase the short term asset portion  $\alpha$  and the futures position  $\Theta$ . For example, assume that martingale efficiency holds both for implied forward rates and futures rates, i.e., the speculative terms in (14a,b) vanish.<sup>15</sup> Since the unregulated futures position  $\Theta^{**} = R_1 \beta \delta \cdot (\gamma - 1) / (1 - \delta^2) < 0$  is short, the cost term in (17b) will either reduce the volume of the short position,  $|\Theta_{reg}^{**}| < |\Theta^{**}|$ , or turn the previously optimal short position into a long position,  $\Theta_{reg}^{**} > 0$ . In any case, regulation results in an *increase* of total bank risk when compared with the unconstrained case (14). Correspondingly, the increase of the portion of short term loans implies a *decrease* of the bank's balance sheet gap

$$(18) \quad \beta - \alpha_{reg}^{**} < \beta - \alpha^{**} ,$$

which results in lower profit opportunities due to a smaller maturity transformation of the bank. In summary, regulation renders *negative* impacts on a risk averse bank's optimal loan-futures-portfolio, both with respect to the scope of positive maturity transformation and the hedging position in the financial futures market.

#### 4. Conclusions

The paper analyzes the role of regulating the financial futures policy of commercial banks, both in markets with imperfect and perfect information. In the case of imperfect information and moral hazard, the paper focusses on the incentive of manager-owners under limited liability to increase the bank's risk via exaggerating the volume of futures contracts (risk incentive or asset substitution problem). If the regulation scheme directly limits the futures volume by an exogenous upper bound, depositors may benefit from the restricted risk potential. However, in the case of indirect regulation, imposing additional costs on the futures volume may both ameliorate and aggravate the risk incentive problem. Thus, the effects of regulation are *ambiguous* under moral hazard.

In the case of perfect information, the analysis relies on a model of a risk averse bank which transforms short term deposits into long term loans (positive maturity transformation), and uses financial futures as an instrument of interest rate risk management. The model presented in the paper shows that financial futures can not only be used to hedge a bank's interest rate risk, but also provide the bank with an enlarged maturity transformation gap (real production effect of futures). The effects of both direct and indirect regulation are *negative*. First, the optimal futures position under the constraint of regulation falls below the unconstrained optimal futures volume, i.e., there is an increase of the bank's interest rate risk. Second, owing to the real production effect, the optimal maturity transformation gap decreases under regulation which leaves the bank with reduced profit opportunities from maturity transformation.

In summary, the possible effects of regulation appear not very promising. While in certain cases a direct regulation of the financial futures volume may be beneficial to the depositors if the bank management's behaviour is governed by moral hazard, those positive incentive effects must be balanced against the negative effects of constraining

a benevolent bank management's use of financial futures as a risk management device. Integrating both aspects in one model of bank behaviour would constitute an interesting task for future research. Secondly, we need a better theoretical understanding of the design of adequate clearing procedures between different open positions in a bank's off-balance-sheet activities (as, e.g., netting by close-out or by novation), which are also not incorporated in the models presented so far. As the analysis in section 3 suggests, the regulator must take into account that any inadequate internal netting scheme not only arbitrarily increases the bank's total risk exposure, but also cuts the bank's profit opportunities from positive maturity transformation.

## Endnotes

- <sup>1</sup> See, e.g. Arnold/Schulte-Mattler (1990, 1992a,b), Becker (1991), Boos/Höfer (1995a,b), Dimson/Marsh (1995), Dewatripont/Tirole (1994), Fama (1985), Fischer/Grünbichler (1991), Grundmann (1992), Merrick/Saunders (1985), Richter (1988, 1991), Rudolph (1989) and the literature cited there.
- <sup>2</sup> While the pure risk incentive is naturally associated with the issuance of risky debt (Merton (1973)), the mixed risk incentive represents an artificial construction capable to demonstrate the existence of non-zero agency costs (Jensen/Meckling (1976)). Though the use of both cases is sometimes intertwined (see, e.g., Gavish/Kalay (1983), Green (1984), Green/Talmor (1986)), a thorough distinction should be significant since some well-known incentive compatible "solutions" of the risk incentive problem (e.g., the issuance of convertible debt (Green (1984))) hinge crucially on the assumption of the mixed version of the incentive problem (see Kürsten (1994) for details).
- <sup>3</sup> For details with respect to the relevant risk-neutral distribution see Harrison/Kreps (1979) or Wilhelm (1988). See also Wilhelm (1986) for some basic shortcomings of this objective function when there is imperfect information.
- <sup>4</sup> The second-order conditions are assumed to be fulfilled (see Green/Talmor (1986), pp. 392, but also Kürsten (1994), p. 195).
- <sup>5</sup> In a sense, this interpretation is unnecessary restrictive as other derivatives (e.g., currency futures) behave similarly (the reader is free to follow alternative interpretations). Our motive is to get some comparability with the results in section 3 which rely explicitly on financial futures policies under symmetric information. We also refrain from possible correlations between the futures position and other bank assets for the ease of demonstration. In section 3, correlation effects are of significance.
- <sup>6</sup> For details, see Arnold/Schulte-Mattler (1992a,b), Dormanns (1990), Schulte-Mattler (1994a).
- <sup>7</sup> Strictly speaking, there are no capital-reserve requirements directed by the Grundsatz I if the financial derivatives are contracted with a default-free clearing-house as the Deutsche Terminbörse, DTB (Schulte-Mattler (1994b)).
- <sup>8</sup> The second-order conditions are assumed to be fulfilled which implies that the denominator is negative (as usual, a lower suffix denotes a partial derivative).
- <sup>9</sup> In view of some recent results with respect to the robustness of other agency theoretic models, the ambiguity is not surprising. For example, Jensen/Meckling's (1976) theory of the optimal capital structure of the firm proves to be generally incorrect (Kürsten (1995a)). Further shortcomings of the agency approach in the context of the design of credit contracts, the optimum firm size, the role of collateral or the theory of credit rationing are discussed elsewhere (Kürsten (1994, 1995b, 1996a,b)).
- <sup>10</sup> This can be assumed without loss of generality (see Kürsten (1993)). Note that there are no refinancing constraints in  $t = 1$  since the bank uses discount instruments (see Koppenhaver (1985a)) for a similar procedure.
- <sup>11</sup> See Bangert (1987) or Gardner/Mills (1988), and Kürsten (1993) for analytical details of the three components of interest rate risk. Note also that the incorporation of elasticity risk renders no further insights for our purposes.
- <sup>12</sup> Again, the assumptions are not necessary for our main results.
- <sup>13</sup> The calculations are tedious, but straightforward since the two partial derivatives form a linear equation system with two unknowns. The proofs are available from the author on request. The case of

perfect hedging ( $\delta = \pm 1$ ) requires appropriate limiting arguments, but renders no further insights (see Kürsten (1993), pp. 202) and is omitted here.

<sup>14</sup> If the expectation term turns the futures position into a long position, our arguments are still valid if  $+c$  is replaced by  $-c$  in (16).

<sup>15</sup> Of course, there are many other parameter constellations which cannot be discussed in detail, but yield similar results. In a sense, the example can be regarded as representative for the general message of the model.

## References

- Arnold, W. and H. Schulte-Mattler, 1990, KWG-Grundsatz I novelliert, *Die Bank* 30, 432-436.
- Arnold, W. and H. Schulte-Mattler, 1992a, Die Eigenkapitalsgrundsätze I und Ia: Bankenaufsichtliche Norm für Kredit- und Marktrisiken (I), *WISU Das Wirtschaftsstudium* 21, 764-772.
- Arnold, W. and H. Schulte-Mattler, 1992b, Die Eigenkapitalsgrundsätze I und Ia: Bankenaufsichtliche Norm für Kredit- und Marktrisiken (II), *WISU Das Wirtschaftsstudium* 21, 879-882.
- Bangert, M., 1987, *Zinsrisiko-Management in Banken*, Wiesbaden.
- Becker, J., 1991, Weiterentwicklung der nationalen und internationalen Bankenaufsicht, in: J. Siebke (ed.), *Finanzintermediation, Bankenregulierung und Finanzmarktintegration (Schriften des Vereins für Socialpolitik)*, 65-78.
- Bester, H., 1987, The Role of Collateral in Credit Markets with Imperfect Information, *European Economic Review*, Vol. 31, S. 887-899.
- Boos, K.-H. and B. Höfer, 1995a, Die Kapitaladäquanzrichtlinie (I), *Die Bank* 35, 285-291.
- Boos, K.-H. and B. Höfer, 1995b, Die Kapitaladäquanzrichtlinie (II), *Die Bank* 35, 359-367.
- Chan, Y.-S.; S.I. Greenbaum and A.V. Thakor, 1992, Is Fairly Priced Deposit Insurance Possible?, *Journal of Finance* 47, 227-245.
- Dewatripont, M. and J. Tirole, 1994, *The Prudential Regulation of Banks*, Cambridge et al.
- Dimson, E. and P. Marsh, 1995, Capital Requirements for Securities Firms, *Journal of Finance* 50, 821-851.
- Dormanns, A., 1990, Grundsatz Ia gemäß KWG neu gefaßt, *Die Bank* 30, 372-375.
- Ederington, L.H., 1979, The Hedging Performance of the New Futures Markets, *The Journal of Finance* 34, 157-176.

- Edwards, F.R., 1977, Managerial Objectives in Regulated Industries: Expense-Preference Behaviour in Banking, *Journal of Political Economy* 85, 147-162.
- Fama, E.F., 1985, What's Different About Banks?, *Journal of Monetary Economics* 15, 29-39.
- Fischer, E.O. und A. Grünbichler, 1991, Risikoangepaßte Prämien für die Einlagensicherung in Deutschland: Eine empirische Studie, *Zeitschrift für betriebswirtschaftliche Forschung* 43, 747-758.
- Galai, D. and R.W. Masulis, 1976, The Option Pricing Model and the Risk Faktor of Stock, *Journal of Financial Economics* 3, 53-81.
- Gardner, M.J. and D.L. Mills, 1988, *Managing Financial Institutions*, Hinsdale.
- Gavish, B. and A. Kalay, 1983, On the Asset Substitution Problem, *Journal of Financial and Quantitative Analysis* 18, 21-30.
- Green, R.C., 1984, Investment Incentives, Debt, and Warrants, *Journal of Financial Economics* 13, 115-136.
- Green, R.C. and E. Talmor, 1986, Asset Substitution and the Agency Costs of Debt Financing, *Journal of Banking and Finance* 10, 391-399.
- Grundmann, W., 1992, Die Einlagensicherungssysteme, *Kreditwesen* 45, 16-20.
- Harrison, M. J. and D.M. Kreps, 1979, Martingales and Arbitrage in Multiperiod Securities Markets, *Journal of Economic Theory* 20, 381-408.
- Hull, J.C., 1993, *Options, Futures, and Other Derivative Securities*, Englewood-Cliffs, N. J.
- Jaffee, D.M., 1986, Term Structure Intermediation by Depository Institutions, *Journal of Banking and Finance* 10, 309-325.
- Jensen, M.C. and W.H. Meckling, 1976, Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure, *Journal of Financial Economics* 3, 305-360.
- Koppenhaver, G.D., 1985a, Bank Funding Risks, Risk Aversion, and the Choice of Futures Hedging Instrument, *The Journal of Finance* 40, 241-255.
- Koppenhaver, G.D., 1985b, Variable-Rate Loan Commitments, Deposit Withdrawal Risk, and Anticipatory Hedging, *Journal of Futures Markets* 5, 317-330.
- Koppenhaver, G.D., 1990, An Empirical Analysis of Bank Hedging in Futures Markets, *The Journal of Futures Markets* 10, 1-12.
- Kürsten, W., 1991, Optimale fix-variable Kreditkontrakte: Zinsänderungsrisiko, Kreditausfallrisiko und Financial Futures Hedging, *Zeitschrift für betriebswirtschaftliche Forschung* 10, 867-891.
- Kürsten, W., 1993, The Asset Transformation Function of Financial Intermediaries, in: R. Flavell (ed.), *Modelling Reality and Personal Modelling, Contributions to Management Science*, Heidelberg, 189-205.

- Kürsten, W., 1994, Finanzkontrakte und Risikoanreizproblem, Mißverständnisse im informationsökonomischen Ansatz der Finanztheorie, Wiesbaden.
- Kürsten, W., 1995 a, Risky Debt, Managerial Ownership and Capital Structure - New Fundamental Doubts on the Classical Agency Approach, *Journal of Institutional and Theoretical Economics* 151, 526-555.
- Kürsten, W., 1995 b, Unternehmenswachstum, Kapitalstruktur und informationsökonomische Komplikationen, in: R. Bühner u.a. (eds.), *Die Dimensionierung des Unternehmens - 56. Wissenschaftliche Jahrestagung des Verbands der Hochschullehrer für Betriebswirtschaft e. V.*, 227-258.
- Kürsten, W., 1996a, Sicherheiten, Investitionsanreize und Anreizkompatibilität - einige Anmerkungen, in: P. Kleinschmidt et al. (eds.), *Operations Research Proceedings 1995*, 365-369.
- Kürsten, W., 1996b, Credit Rationing and Collateral in Markets with Imperfect Information, University of Magdeburg, working paper.
- Merrick, J.J. and A. Saunders, 1985, Bank Regulation and Monetary Policy, *Journal of Money, Credit and Banking* 17, 691-717.
- Merton, R. C., 1973, Theory of Rational Option Pricing, *Bell Journal of Economics and Management Science* 1, 141-183.
- Merton, R.C., 1977, An Analytic Derivation of the Cost of Deposit Insurance and Loan Guarantees: An Application of Modern Option Pricing Theory, *Journal of Banking and Finance* 1, 3-11.
- Morgan, G.E.; Shome, D.K. and S.D. Smith, 1988, Optimal Futures Positions for Large Banking Firms, *The Journal of Finance* 43, 175-195.
- Ratti, R.A., 1980, Bank Attitude Toward Risk, Implicit Rates of Interest, and the Behaviour of an Index of Risk Aversion for Commercial Banks, *Quarterly Journal of Economics* 95, 309-331.
- Richter, R., 1988, The New Institutional Economics Applied to Monetary Economics, *Journal of Institutional and Theoretical Economics* 114, 208-224.
- Richter, R., 1991, Bankenregulierung aus der Sicht der Neuen Institutionenökonomik, in: J. Siebke (ed.), *Finanzintermediation, Bankenregulierung und Finanzmarktintegration (Schriften des Vereins für Socialpolitik)*, 43-64.
- Ronn, E.I. and A.K. Verma, 1986, Pricing Risk-Adjusted Deposit Insurance: An Option-Based Model, *Journal of Finance* 41, 871-895.
- Rudolph, B., 1989, Eigenkapitalanforderungen an die Kreditinstitute im Rahmen der internationalen Bankrechtsharmonisierung, *Die Betriebswirtschaft* 49, 483-496.
- Rudolph, B., 1995, Europäische Eigenkapitalanforderungen im Wertpapierbereich im Lichte des Wachstums der derivativen Märkte, *ifo Studien* 41, 89-117.
- Santomero, A.M., 1983, Fixed Versus Variable Rate Loans, *The Journal of Finance* 38, 1363-1380.

- Saunders, A., 1987, The Risk and Regulation of Banks Off-Balance Sheet Innovations, *Finanzmarkt und Portfolio Management* 1, 32-39.
- Schulte-Mattler, H., 1994a, Bankaufsichtliche Eigenkapitalnormen für Marktrisiken im Vergleich, *Die Bank* 34, 93-98.
- Schulte-Mattler, H., 1994b, Ausfallrisiko und bilaterales Netting von OTC-Finanzderivaten, *Die Bank* 34, 302-307.
- Veit, E.T. and W. Reiff, 1983, Commercial Banks and Interest Rate Futures: A Hedging Survey, *The Journal of Futures Markets* 3, 283-293.
- Wilhelm, J., 1982, Die Bereitschaft der Banken zur Risikoübernahme im Kreditgeschäft, *Kredit und Kapital* 15, 572-601.
- Wilhelm, J., 1985, Arbitrage Theory, *Lecture Notes in Economics and Mathematical Systems*, Berlin et al.
- Wilhelm, J., 1986, Zur Interessenlage von am Unternehmensprozeß Beteiligten, working paper, Universität Passau.
- Wilhelm, J., 1988, Erwartungsstruktur und bestandsökonomische Darstellung aus kapitalmarkttheoretischer Sicht, in: B. Rudolph und J. Wilhelm (eds.), *Bankpolitik, finanzielle Unternehmensführung und die Theorie der Finanzmärkte - Festschrift zum 60. Geburtstag von Hans-Jacob Krümmel*, Berlin, 475-500.

