BANK OF GREECE

MODELING THE COMPONENTS OF MARKET DISCIPLINE

Faidon Kalfaoglou
Alexandros Sarris

Working Paper

No. 36 April 2006

BANK OF GREECE
Economic Research Department – Special Studies Division
21, E. Venizelos Avenue
GR-102 50 Athens
Tel: +30210-320 3610
Fax: +30210-320 2432

www.bankofgreece.gr

Printed in Athens, Greece
at the Bank of Greece Printing Works.

ISSN 1109-6691

MODELING THE COMPONENTS OF MARKET DISCIPLINE

Faidon Kalfaoglou
Bank of Greece

Alexandros Sarris
Food and Agricultural Organization of the United Nations
and University of Athens

ABSTRACT

Market discipline has emerged as a complementary tool for banking supervision. Its effectiveness depends on bank disclosure policy and on market participant's ability to monitor bank riskiness and impose discipline. We develop a game theoretic model where the bank sends a signal about its riskiness to market participants (the stakeholders) and they, in turn, evaluate the credibility of the signal and make inferences about bank soundness. The model takes into account both bank disclosure policy and market participant reaction to disclosure. The outcome of the model indicates that market participants have the ability to monitor risk but lack the ability to impose actions that reflect this assessment. The theoretical conclusion of the model is empirically tested against data from Greek banking sector. A transparency index is developed based on publicly available data and undisclosed supervisory data but the results are contradictory and do not always confirm the theoretical predictions.

Keywords: Market discipline, transparency, bank risk
JEL classification: G18, G21, G28

The authors wish to thank Heather Gibson for helpful comments. The views expressed in this paper are personal and not binding for the respective institutions of the authors. Alexandros Sarris is currently on leave from the University of Athens.

Correspondence:
Faidon Kalfaoglou,
Department for the Supervision of Financial Institutions,
Bank of Greece, 3 Amerikis Street,
10250 Athens, Greece,
Tel.: +30 210 320 5160
Fax: +30 210 320 5400
E-mail: fkalfaoglou@bankofgreece.gr

1. Introduction

For a long period of time banking supervision was driven by regulation discipline, where the regulatory authorities set the rules and banks were obliged to obey. During the '90s it was made clear that an alternative mechanism for supervision was necessary. Market discipline has, subsequently, emerged as the major complementary tool for supervision since it is considered a mechanism that can limit excess risk-taking. Market discipline refers to the measures taken by the market participants for banks that do not exhibit the appropriate risk-taking behaviour. It depends on bank disclosure policy as well as market participants incentives to undertake the necessary actions. This paper develops a model that takes into account both aspects.

The motivation for this paper stems from the third pillar of the New Capital Adequacy Framework which is entirely devoted to market discipline and outlines a set of disclosure recommendations which are expected to enhance transparency and allow market participants to assess key information for banks' financial position. Pillar III seems to focus on the availability of information and little concern has been shown whether the interested parties gather, process and interpret information in a consistent and appropriate manner. The conception underlying this focus is that with information, like any other normal homogeneous good, more is always better than less. More available information automatically translates into greater transparency and no potential frictions in the process of transmitting information are taken into account. However, market discipline depends on the ability of the market to accurately assess the condition of the bank and on the ability to impose managerial reactions that reflect those assessments. Thus, the model incorporates bank disclosure policy as well as the ability of market participants to monitor bank riskiness and influence bank actions.

The paper is divided into four sections. The first section analyses the concept of market discipline and its components, the bank's disclosure policy, the ability of the market to accurately assess the condition of the bank and the ability to impose managerial reactions. The second section develops a game theoretic model that incorporates all components of market discipline. The model indicates that market participants have the ability to monitor the risk but lack the ability to impose bigger transparency to riskier banks and specifies the hypotheses for testing these results. In the third section empirical investigation of the hypotheses is undertaken with reference to Greek banking sector. The results are contradictory and are not consistent with all the predictions of the theoretical model.

2. The concept of market discipline

Market discipline refers to a market-based incentive mechanism where market participants "punish" a bank that does not exhibit the appropriate risk-taking behaviour. The "punishment" may manifest itself in three forms, *the price effect*, where investors require higher returns on bank securities, *the quantity effect*, where depositors withdraw their funds and *the valuation effect*, where stock market participants drive down the bank value. However, whether "punishment" occurs in practice depends on market participants' incentives. They have to have some funds at risk so that the possibility of loss provides them with the incentive to monitor and evaluate the bank risk. The effectiveness of market discipline depends on three aspects, the bank's disclosure policy, the ability of the market participants to assess bank's riskiness (ability to monitor) and the ability to impose discipline (ability to influence).

2.1 Bank disclosure policy

The regulatory framework requires some minimum disclosure of bank activities (mandatory disclosure) but often banks undertake the initiative of disclosing additional elements (voluntary disclosure). The mandatory disclosure is a regulation compliance issue whereas the voluntary disclosure is a corporate governance issue. The voluntary disclosure problem of the bank can be analysed as follows. Assume that λ is the required market return. If θ_1 is the necessary information set in order to judge the bank riskiness, then λ_1 is the required return on bank assets with $\lambda_1 = f(\theta_1)$ and $\lambda_1 > \lambda$. This separates the (λ,θ) space into two sub-spaces where investment decisions can be made (Figure 1a). If market participants receive a noisy information set θ_2, subset of θ_1, then there exist a $\lambda_2 = f(\theta_2) > \lambda_1$ as investment criterion. The combination of the two cases creates two new sub-spaces (Figure 1b). In area A Type I error exists, because the bank did not manage to attract investment, although sound, while in area B Type II error exists, because the bank managed to attract investment, although unsound. The disclosure policy objective of the bank is to minimise the Type I error by sending the appropriate message to the market.

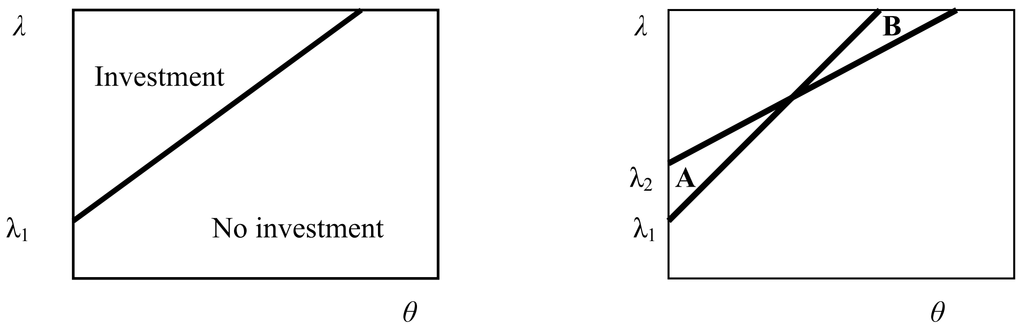

Figure 1a Figure 1b

The subject of information disclosure stirred the interest of researchers after the publication of Crowford and Sobel's (1982) paper, where the existence of complete or partial disclosure equilibrium is analysed. Recent surveys of the literature (Healy and Palepu 2001, Verrecchia 2001) provide evidence that the optimal disclosure policy is the partial disclosure equilibrium. In the absence of a proper market-based incentives mechanism, a bank may take the initiative to introduce noise into the disclosure and undertake a parallel effort to persuade the market participants (persuasion game). The regulatory authorities can alleviate the problem by introducing enhanced disclosure regulation. There is little doubt that an enhanced disclosure regime can mitigate the effects of a banking crisis (Hyytinen and Takalo 2004) and reduce the volatility of bank stocks (Baumann and Nier 2004). However, not all forms of disclosure regulation lead to the socially optimal equilibrium. There are situations where the benefits of increased transparency are detrimental. Several studies (Cordella and Yeyati 1998, Blum 2002 and Matutes and Vives 2000) show that, in cases where bank risk is exogenous and beyond the control of the bank, enhanced disclosure can lead to reduction of the bank's value. Hyytinen and Takalo (2002), who introduce in their model elements of disclosure cost and deposit guarantee schemes, draw similar conclusions. When the bank cannot exploit the economies of scope in the monitoring of its investments and the coverage of the deposit guarantee is wide, increased transparency leads to a higher probability of bankruptcy.

2.2 The ability to monitor

The ability to monitor refers to the ability of the market participants to assess the financial condition of the bank from available public information. It is often argued that banks are inherently opaque institutions for an outsider to judge, the main reason being their loan portfolio. Loans are privately negotiated contracts where some form of discretion is inevitable, which results in a lack of transparency and liquidity. Further, the volatility of the trading portfolio introduces additional ambiguity into the assessment of the bank's financial condition. Mark to market valuations tend to be rather unpredictable and changes may underpin the financial position over-day. This further raises the question of risk management techniques. The development of internal models for risk measurement and the disclosure of the results is clear progress (Jorion 2002), but one should be cautious because these techniques involve complicated mathematical models that vary from bank to bank and any peer comparison is by no means clear-cut.

There are some empirical papers that take up the issue of the ability of outsiders to monitor and interpret the information in a consistent and appropriate manner. The conclusion of a paper by Jordan, Peek and Rosengren (2000) is that "…for a country (USA) that is a leader in advocating enhanced transparency for banks and where banks have long been required to provide substantial detail on non-performing loans, loan loss reserves, capital ratios, and on- and off-balance sheet positions, it is surprising that formal (supervisory) action announcements would be viewed as being so informative that market participants would reduce the value of a bank as much as 20%". They find that supervisory information releases provide significant new information to financial markets, resulting in a 5% decline in stock prices, on average. Morgan (2002) examines split ratings, that is, differences in ratings by rating agencies, and concludes that the likelihood of a split rating is greater in cases of banks in relation to other sectors and increases as the proportion of loans in bank assets increases.

2.3 The ability to influence

Even if markets can identify a bank's real financial condition, it is not obvious that the action taken and the signals sent can influence the actions of the bank's management. This is mainly attributed, in the literature, to the heterogeneity of agents with respect to their individual requirements for information. One can identify at least four groups of market participants interested in the bank's financial condition, depositors, bondholders, stockholders and supervisors.

The depositors, to the degree that their deposits are protected by deposit insurance schemes, have no incentive to take any action since there are no funds at risk. Usually they do not have the expertise and cannot afford the cost of monitoring. Their actions are mainly driven by liquidity needs. Bondholders may have more incentives but these are somehow diluted by implicit protection schemes such as liquidity facilities, minimum capital requirements, etc. In addition, bondholders are less interested in the upside potential of the bank and more concerned about downside risk. They mainly focus on default avoidance and they try to influence the bank's actions in that direction. A particular class of bondholders, the subordinated bondholders, may have more incentives if the instruments are actively traded in the market. There is a voluminous literature that advocates the mandatory use of subordinated debt to improve market discipline (Herring 2004) and empirical evidence on its effectiveness (Sironi 2003, B.I.S 2003). As far as stockholders are concerned, their perspective is different from that of depositors or bondholders. Stockholders may have a moral hazard opportunity to opt for riskier investments as long as they are compensated for the additional risk. Under such circumstances they may increase the value of their claims by increasing bank riskiness, thus rendering them unlikely candidates to impose discipline. Finally, the supervisors require information in order to ensure stability and deposit protection. They focus on bankruptcy issues so their information needs are more aligned with bondholders.

The heterogeneity of agents requiring information may force the bank to regard information as a differentiated good that can be tailored to the specific needs of each group. This poses further risks. If the receivers can communicate they will be confronted with multiple messages that may increase confusion. In addition, channelling private information to different groups creates additional informational asymmetries.

Empirical evidence on the ability of market participants to influence bank management action is focused on whether the risk premium on different debt instruments is strong enough to discipline banks. Morgan and Stiroh (2001), Gropp *et al* (2002) find that the bond market prices banks efficiently so it can exercise influence. In contrast, Bliss and Flannery (2001) conclude that bond and stock market signals are not strong enough to significantly affect managerial behaviour. Similar conclusions are drawn by Kwan (2004). Other studies focus on depositors' ability to influence bank actions. Caprio and Honohan (2004) conclude that even unsophisticated markets can provide discipline but Wilson, Rose and Pinfold (2004), focusing on New Zealand market, fail to find evidence for this.

3. Signaling game between the bank and the market

The bank's disclosure policy can be analyzed as a game of strategic interaction between the bank and the market. It is a signaling game since it includes the interaction of a sender and a receiver. In every signaling game there are three parameters, the type of sender $t_n \in (t_1, t_2 ... t_\nu)$, the type of message $m_l \in (m_1, m_2 ... m_\lambda)$, the reaction of the receiver $a_k \in (a_1, a_2 ... a_\kappa)$, as well as the payoff functions of the sender $U^S(t_n, m_l, a_k)$ and the receiver $U^R(t_n, m_l, a_k)$. The objective of the game is the estimation of parameters (t_n, m_l, a_k) that maximise the payoff functions. A signaling game results in Nash equilibrium, which is determined by backward-induction and should satisfy three conditions (Gibbons 1992):

1. After the transmission of the message (m_l), the receiver observes the message and forms a belief about the type of sender $p(t_n / t_1 ... t_\nu)$ with a probability distribution $h(t_n / m_l)$

2. For each message (m_l), the reaction of the receiver $a^*(m_l)$ should maximize his expected payoff function given his belief. Consequently, $a^*(m_l)$ is the result of $\max \sum h(t_n / m_l) U^R(t_n, m_l, a_k)$

3. For each message $m^*(t_n)$ the sender should maximize his expected payoff function *given* the strategy of the receiver $a^*(m_l)$. Consequently, $m^*(t_n)$ results from $\max U^S(t_n, m_l, a^*(m_l))$.

The market usually does not accept the message as such, but rather proceeds to decide on its credibility. Usually the credibility of the message is connected with the type of sender $t_n \in (t_1, t_2 ... t_\nu)$. The receiver observes the type of sender, determines the reliability of the message and decides on his strategy, which leads to a Nash equilibrium (Gibbons 1992). From the evaluation of the message the receiver revises his belief regarding the type of sender and the probability distribution $h(t_n / m_l)$ according to Bayes rule as $h^*(t_n / m_l) = p(t_n / t_1..t_v) / \sum p(t_n / t_1...t_v)$. If the receiver concludes that there is no new reliable information[1], then his reaction results from:

$$\max \sum h(t_n / m_l) U^R(t_n, m_l, a_k)$$

whereas if he concludes that there is new reliable information then his reaction results from:

$$\max \sum h^*(t_i / m_l) U^R(t_n, m_l, a_k)$$

3.1 The framework of the signaling game

In order to model the components of market discipline, we consider a dynamic Bayesian game with incomplete information. The game is dynamic because the participants' actions are successive and at each stage each participant knows all the background information of the game. It is also an incomplete information game because each participant is uncertain about the payoff function of the other side. Finally, it is a Bayesian game because the beliefs are revised according to Bayes rules. The game is developed in three stages.

First stage (st1): the bank draws funds in the form of deposits and undertakes N uniform and independent investment initiatives with initial probability of success q_{prior}. The bank is valued according to this probability.

Second stage (st2): with the arrival of new information the bank revises the probability of success q_{post} and determines the number of investment initiatives that are expected to succeed. At the same time, it makes a decision about the disclosure policy. The market, in turn, activates a credibility control mechanism and revises its risk assessment of the bank.

Third stage (st3): the uncertainty is resolved and market participants have complete information about the outcome of investments and value the bank accordingly.

[1] If the game is one period game, the sender cannot built a truth-telling reputation.

More analytically,

First stage (st1) : In the first stage the bank draws deposit funds D with constant cost r (perfect competition) and place them in *N* uniform and independent investment initiatives. We consider that the drawn funds and the placements made are of the same maturity, so the sole risk that the bank faces comes from the quality of investment initiatives (credit risk). The objective of the bank is the maximisation of investments return and hence the maximisation of its value. Therefore, we can consider a monotonic transformation of the payoff function

$$V^S_{prior}(t_n, m_l, a_k) = F\left[U^S_{prior}(t_n, m_l, a_k)\right]$$

where $V^S_{prior} = a\ priori$ value of bank according to the estimation of the bank itself.

The transformed function (the valuation) conveys the same information set as the initial function (payoff function) and by assuming $F' > 0$, it is ensured that the V^S_{prior} and U^S_{prior} always move in the same direction.

The market participants also have an initial opinion about the outcome of the *N* investment initiatives and value the bank accordingly. This suggests another monotonic transformation of the payoff function as:

$$V^R_{prior}(t_n, m_l, a_k) = G\left[U^R_{prior}(t_n, m_l, a_k)\right]$$

where $V^R_{prior} =$ the *a priori* value of bank according to the market,

with $G' > 0$, to ensure that V^R_{prior} and U^R_{prior} always move to the same direction. In the initial stage we can consider that there is information symmetry and consequently $V^S_{prior} = V^R_{prior}$.

Further, each of the *N* investment initiatives has a real return R_i, $i = 1...N$, which depends on two factors, the prior probability of success q_{prior}, and an external shock *S* that influences all investment initiatives but in different ways. Consequently:

$$R_i = f(q_{prior}, S_i) \text{ with } \partial R_i / \partial q_{prior} > 0,\ \ \partial^2 R_i / \partial q^2_{prior} < 0,\ \ \partial R_i / \partial S_i > 0.$$

Since the effect of shock *S* cannot be accurately forecasted, the return R_i is unknown but it is assumed that it is drawn from a known distribution, the uniform distribution over the interval $[R-1/2\gamma, R+1/2\gamma]$ where $\gamma \in [0,2R]$[2]. The valuation of the investment initiatives will be based on the expected value of each investment, that is, $E(R_i) = R$, using the binomial model (Shin 2003). Each successful investment, with probability q, represents a "rise" in the binomial tree of value, while a failed investment, with probability $1-q$, a "decline". In the case of k successes the final value of investments is $IV_{final} = (1+R)^k$. In any interim period, the value of investments is the expected value of IV_{final}, that is, $IV_{\text{int}\,erim} = E(IV_{final})$. $IV_{\text{int}\,erim}$ can be approximated from the cumulative binomial distribution as

$$IV_{\text{int}\,erim} = \sum_{k=0}^{N} \binom{N}{k} [q(1+R)]^k [1-q]^{N-k}$$

which simplifies to $IV_{\text{int}\,erim} = (1+qR)^N$

Thus, the value of investments in the initial period is:

$$IV_{prior}^{S} = (1+q_{prior}R)^N$$

<u>Second stage (st2) :</u> In the second stage the arrival of new information results in agents revising the initial probability of success. The revised probability depends on the uncertain external shock S and as a result it cannot be estimated with certainty. The effects of the external shock can be controlled with the implementation of a monitoring process. The monitoring technology can be described with a Cobb-Douglas type function:

$$q_{post} = q_{prior}^{c} M^{d}$$

where the posterior probability of success $q_{post} \in [0,1]$ is a function of prior probability of success q_{prior} and the ability to monitor the investment initiatives $M \in [0,1]$. The coefficients $(c,d) \in [0,1]$ indicate elasticity of initial probability and monitoring effort. We consider that $c+d \neq 1$, since otherwise the equation is homogenous of first degree, meaning that if the initial probability or the monitoring effort doubles, the final probability of success doubles, which does not correspond to

[2] The upper limit on risk exists so as to ensure positive expected returns and to take into account the restrictions that the bank faces.

reality. Consequently, the final probability of success is proportional to the initial probability of success. The bank cannot significantly affect the final probability of success unless the initial probability is satisfactory. This deficiency is partially covered by the monitoring effort *M,* the size of which will determine the revised probability of success.

According to the above specification:

$$\frac{\partial q_{post}}{\partial M} = dq_{prior}^{c} M^{d-1} > 0 \text{ and } \frac{\partial^2 q_{post}}{\partial M^2} = d(d-1)q_{prior}^{c} M^{d-2} < 0 \text{ since } 0 \le d \le 1$$

The marginal effect of monitoring effort on the probability of success is positive and bigger for investments with a better initial probability of success. Further, the monitoring effort includes cost. The cost of monitoring can be determined as:

$$C(M) = \frac{m}{2} \times M$$

with m>0 the cost per "unit of" monitoring.

The optimal amount of monitoring *M** can estimated endogenously from the maximisation of bank profits. If

$$\max \pi = q_{post}\left(R - \rho D\right) - \frac{mM}{2}$$

where R = the expected return of investments,

r = cost of capital,

D = deposit funds,

$$\Rightarrow \max \pi = q_{prior}^{c} M^{d}\left(R - \rho D\right) - \frac{mM}{2}$$

The first order condition is:

$$\frac{\partial \pi}{\partial M} = dq_{prior}^{c} M^{d-1}\left(R - \rho D\right) - \frac{m}{2} = 0$$

$$\Rightarrow M^{*} = q_{prior}^{c(1-d)}\left[2d \times \frac{(R - \rho D)}{m}\right]^{1-d}$$

Given the initial quality of investment q_{prior}, the monitoring effort M^* is an increasing function of the expected return, R, but a declining function of the deposit funds, D. The new value of the probability of success is given by:

$$q_{post} = q_{prior}^{c} M^{*d} = q_{prior}^{c(1+d-d^2)} \left[2d \times \frac{(R-\rho D)}{m} \right]^{d(1-d)}$$

Based on the revised probability of success, the expected value of investment initiatives is:

$$IV_{post}^{S} = \left(1 + q_{post} R\right)^{N}$$

<u>In third stage (st3)</u> : In the third stage any uncertainty is resolved and market participants have complete information to value the bank. The final outcome R_i of each investment initiative is known, therefore the final assessment of the bank is $V_{final}^{S} = V_{final}^{R}$.

3.2 Transparency of bank disclosure and the reaction of the market

As analysed above, the parameters of the signaling game $\left(m_l, a_K\right)$[3] can be extracted endogenously from the maximisation of bank value. In the first and last stage of the game there is symmetric information, therefore the analysis focuses on the intermediary stage, where the disclosure policy and the reaction of the market participants are determined.

Assume that in the intermediary period, st2, the bank forms the following views:

K = investment initiatives that are expected be successful

L = investment initiatives with ambiguous final outcome

where K + L = N

The bank can apply two alternative policies, the policy of complete disclosure, where the actual vector $\left(K, L, q_{post}\right)$ is disclosed, and the policy of partial disclosure, where

[3] The parameter for the type of the bank $t_n \in \left(t_1, t_2 ... t_v\right)$ is not used since it is assumed that the market initially cannot determine whether a bank is “good” or “bad” in relation to transparency.

the vector $\left(aK, bL, q^{*}_{post}\right)$ is disclosed. If the bank chooses to disclose[4] $\left(K, L, q_{post}\right)$, then $V^{S}_{post} = V^{R}_{post}$, since there is no diverging beliefs between bank and market. If the bank introduces noise and discloses $\left(aK, bL, q^{*}_{post}\right)$ then $V^{S}_{post} \neq V^{R}_{post}$ since $\left(K, L, q_{post}\right) \neq \left(aK, bL, q^{*}_{post}\right)$ and $(a, b) \neq 1$

According to the above approach, the information vector is three-dimensional and the bank should decide into which element to introduce noise. It is more effective to disclose the probability of success and introduce noise into the number of successful investment initiatives. The available vector of information is (K, L) and it decides to disclose (aK, bL) where $1 \leq a \leq \omega$[5] and $0 \leq b \leq 1$. *The parameters* (a, b) *reflect the degree of transparency since they determine the degree of noise in the message.* If $a = 1$ and $b = 1$ the message does not contain any noise while if $a \neq 1$ and $b \neq 1$ the message contains a certain degree of noise[6]. The introduction of noise should not be understood as fraud. It is rather aiming at gaining sufficient time for corrective actions and moderating the internal and external pressure. The disclosure of all available information is likely to limit bank choices since public disclosure is not a free good, especially if it works.

The bank, when deciding appropriate disclosure, faces certain restrictions. Firstly, the restriction of revelation, that is, the possibility that the market determines whether the disclosure was false or true in a later stage. Moreover, the bank itself faces an uncertainty with respect to the final outcome of its investments. Even for failed investments it faces the dilemma whether to declare them impaired or to renew the financing.

Another factor that affects the degree of noise is the intensity of the agency problem in the bank. If the bank is "management controlled" and the compensation of

[4] The bank could choose no disclosure. In our study this case will be ignored. We consider the case where the information that is disclosed by the bank is essential for its valuation and not just cheap talk. Therefore the message is part of the market participant's payoff function.

[5] We assume that the market knows the total number N of investment initiatives and consequently $a \geq 1$. In addition, we place an upper limit ω on the coefficient value since it should be the case that $a \leq N / K$. We also consider that the value of a should not be very high since then disclosure would touch the limits of fraud. This restriction will be useful later.

[6] We differ from the definitions of Boot and Schmeits (2000) and Hyytinen and Takalo (2002) who define transparency as the probability that market participants (the depositors in their models) determine the monitoring ability of the bank.

the managers is related to the performance disclosed, then the degree of noise is likely to be important. In addition, the degree of noise depends on the possibility of free riding on internal information. Banks, being information intensive organisations, gather and process considerable amounts of information, which is at the disposal of managers without cost. Efforts to exploit internal information would involve introducing noise into the message.

Finally, the bank faces the restriction of regulation. The bank has as incentive to maximise a, $\max(a)$, and minimise b, $\min(b)$. If transparency regulations exist, the bank may not have absolute discretion over its disclosure. It is likely that a subset (aK, bL) may not be compatible with the rules and the supervisory authority requires from the bank an alternative disclosure. In our model we consider that the bank incorporates all the above restrictions in its decision to disclose (a,b).

The model concludes with the specification of the market's reaction, that is, its control over the credibility of the message. Control over credibility can take two forms:

- Redefinition of (a,b) at the time of disclosure

- Estimation of the final (a,b) based on the disclosure.

In the first approach the valuation of the bank is short-term and myopic. By contrast, the second approach is more dynamic and takes the bank's final value into consideration. Since the market knows the total number of investment initiatives *N*, it is enough to focus on only one parameter, the parameter (a) and imply the parameter (b). Consequently the control over credibility takes the form of the determination of a new parameter:

$a'' = a + \eta$.

The parameter (η) introduces a stochastic element into the reaction of the market[7] and leads to the estimation of the probability $p(a''K / aK)$ where:

aK = the number of success the bank discloses

[7] If $E(\eta) = 0$ and $\sigma\eta = 0$, then the private information of the market does not modify the disclosure policy of the bank.

$a''K$ = the final number of successful investment initiatives

$p(a''K / aK)$ shows the probability that the final number of successful investment is $a''K$ based on the disclosed aK. The final value of the investments according to the market is:

$$IV^{R}_{final} = p(1+R)^{a''K} = p(1+R)^{aK}(1+R)^{\eta K}$$

In any interim period the market determines the value of the investments $IV^{R}_{interim}$ as the expected value of IV^{R}_{final} based on aK successful investment initiatives and the cumulative binomial distribution with (ηK) probable successful initiatives with joint probability $(q_{post} \times p)$ and $(N - \eta K)$ failed investment initiatives with joint probability $(1 - q_{post} \times p)$.

$$IV^{R}_{interim} = (1+R)^{aK} \sum_{\eta K=0}^{N-\eta K} \binom{N-\eta K}{\eta K} (q_{post}\, p(1+R))^{\eta K} (1 - q_{post}\, p)^{N-\eta K}$$

$$\Rightarrow IV^{R}_{interim} = (1+R)^{aK} (1 + q_{post}\, pR)^{N}$$ [8]

3.3 Comparative static analysis and hypothesis testing

The above analysis has specified two parameters, $p(a''K / aK)$ which can be seen as the perceived probability of no-default and (a) which reflects the disclosure policy of the bank. In equilibrium there is an interaction between the market (p) and the bank (a), which is reflected in the maximisation of bank value. The value of the bank (V_{post}) is defined as the present value of all future cash flows (π_{+t}) under the condition of no bankruptcy up to $(+t)$. Consequently, the maximisation problem can be written:

$$\max V_{post} = \left[\delta\pi + \delta^2 p\pi_{+1} + \delta^3 pp_{+1}\pi_{+2} + \ldots\right]$$

$$s.t \quad \pi_{+t} > 0 \ \ \forall t$$

where $\delta \in [0,1]$ is the discount factor of future cash flows.

From the first order conditions we can determine the parameters (p) and (a) as functions of the bank's riskiness (q_{post}).

The first order conditions for the maximisation problem can be written:

$$\frac{\partial V_{post}}{\partial p} = 0 \text{ which simplifies to } F = \frac{\partial \pi}{\partial p} + V_{post} = 0$$

$$\frac{\partial V_{post}}{\partial a} = 0 \text{ which simplifies to } G = \frac{\partial \pi}{\partial a} + \frac{\partial p}{\partial a} V_{post} = 0$$

The profit function can be written as:

$$\pi = p(R - \rho D) - \frac{mM^*}{2}$$

and based on the estimation $IV_{\mathrm{int}\,erim}^{R}$ of market participants for the value of the investment initiatives,

$$\pi = (1+R)^{aK}\left(1 + q_{post} pR\right)^{N} - \rho D - \frac{m}{2} M^*$$

$$\Rightarrow \frac{\partial \pi}{\partial p} = N q_{post} R (1+R)^{aK} \left(1 + q_{post} pR\right)^{N-1}$$

$$\Rightarrow \frac{\partial \pi}{\partial a} = K (1+R)^{aK} \left(1 + q_{post} pR\right)^{N} \ln(1+R)$$

Thus,

$$F = N q_{post} R (1+R)^{aK} \left(1 + q_{post} pR\right)^{N-1} + V_{post} = 0$$

$$G = K (1+R)^{aK} \left(1 + q_{post} pR\right)^{N} \ln(1+R) + \frac{\partial p}{\partial a} V_{post} = 0$$

The above equations determine the equilibrium level of transparency and the probability of success of the investment initiatives according to the market. Then our fundamental objective is to isolate the effect of the two parameters on the bank's riskiness, which is inversely related to the probability of success q_{post}.

---

[8] The equation holds for $a'' \geq a$, that is, $\eta \geq 0$. This is possible if the restriction on the coefficient a is valid and it does not take very high values so as the noise does not reach the limits of fraud (see footnote 7).

The first order conditions allow us to perform comparative statics analysis and to estimate the relations. The formal equations of comparative static analysis can be written as:

$$\begin{bmatrix} \frac{\partial F}{\partial a} & \frac{\partial F}{\partial p} \\ \frac{\partial G}{\partial a} & \frac{\partial G}{\partial p} \end{bmatrix} \begin{bmatrix} \frac{\partial a}{\partial q_{post}} \\ \frac{\partial p}{\partial q_{post}} \end{bmatrix} = \begin{bmatrix} -\frac{\partial F}{\partial q_{post}} \\ -\frac{\partial G}{\partial q_{post}} \end{bmatrix}$$

These can be solved for the two partial derivatives according to Cramer's rule and after some tedious but straightforward algebra we reach the conclusion that $\frac{dp}{dq_{post}} > 0$ (Hypothesis 1). This states that the market estimation of probability of success (p) and the actual probability of success (q_{post}) are positively correlated. Therefore, we can reach the conclusion that the market has the ability to evaluate the bank riskiness, that is, it has the ability to monitor.

We can also derive the derivative $\frac{da}{dq_{post}} < 0$ (Hypothesis 2), which states that the actual probability of success (q_{post}) and the noisiness of the bank's chosen disclosure policy[9] (a) are negatively correlated. Riskier banks choose a less transparent disclosure policy and the market cannot change that by forcing them to be more transparent. Therefore market participants cannot impose discipline on the banks' decisions, at least on its transparency decisions.

4. Empirical investigation

For empirically testing the specified hypotheses, we need three types of information:

- the risk assessment according to financial data
- the risk assessment according to the market and
- a transparency index.

[9] Recall that $1 \leq a \leq \omega$ and $a \to 1$ means that greater transparency, whereas $a \to \omega$ means lower transparency.

A *positive* relation between the risk assessment according to the market and the risk assessment according to financial data indicates that the assessment of the market is correct and thus the market participants have the ability to assess the bank riskiness. As a consequence they have the ability to monitor the bank financial condition and thus hypothesis 1 is satisfied. A *negative* relation between the risk assessment according to financial data, or the risk assessment according to the market if hypothesis 1 is valid, and the transparency index indicates that riskier banks are less transparent and thus market participants do not have the ability to impose greater transparency on them. Generalising, we can assume that they do not have the ability to influence the bank actions. We test the two hypotheses using data from Greek banking sector.

4.1 Risk assessment according to financial data

Our sample consists of 9 commercial banks listed on Athens Stock Exchange (ASE)[10] and the sample data runs from 1993 to 2004[11]. The risk assessment according to financial data is based on the CAMELS system. Bognini *et al* (2002) assess that CAMELS ratings exhibit the best predictive power, after bond risk premiums[12].

For the evaluation of each CAMELS component we use a variety of ratios and each financial ratio X_i is transformed to score B_i as $B_i = prob[X_i],\ X_i \to N(0,1)$. This probability is considered to be the final score for each ratio. The total score of each component is calculated as a simple average of scores

$$B_j = \frac{1}{n}\sum_{i=1}^{n} B_i$$

with j = *C, A, M, E, L, S* and n = the number of ratios in each risk component

Then the aggregate CAMELS score (SCORE) is calculated as a weighted average:

$$SCORE = (w_1 C + w_2 A + w_3 M + w_4 E + w_5 L + w_6 S) * size\ , \quad \sum_{i=1}^{6} w_i = 1$$

[10] We exclude banks with few data due to recent listing.

[11] The sample period begins from 1993, first year of the application of Greek Banking Accounting Standards and ends in 2004 the final year of these standards application, since afterwards IFRS are adopted.

[12] For the Greek banks there is no adequate number of active bond issues in order to estimate the risk premiums.

The weights are set to $w_1 = 0.2, w_2 = 0.2, w_3 = 0.15, w_4 = 0.2, w_5 = 0.15, w_6 = 0.10$

following a judgment on the significance of each component. In addition, the total score is normalised on the size of the bank to reflect "too big to fail" policy, as:

$size = prob[\log(assets)]$, $[\log(assets)] \to N(0,1)$

Based on the above methodology we calculate two aggregated CAMELS scores, the actual risk assessment ($SCORE_1$) and the disclosed risk assessment ($SCORE_2$). The actual risk assessment ($SCORE_1$) is calculated from prudential reports the banks submit to the Bank of Greece (see Appendix 1). These reports are confidential and, presumably, are not disclosed to market participants[13]. We assume that the data in these reports contain superior information for evaluating the soundness of a bank. This is confirmed by Berger *et al* (2000) for the US market and thus we consider the ($SCORE_1$) as the actual bank risk.

Further, we calculate the disclosed risk assessment ($SCORE_2$) based *solely* on the public information set of the market participants, that is, the disclosed information. Thus we construct a second CAMELS score based on financial ratios calculated from published financial statements (see Appendix 2).

4.2 Risk assessment according to the market

The market participants possess public and private information. In order to capture both we use the beta coefficients as risk indicators, instead of ($SCORE_2$). A simple market model, with daily data, is applied for each year in the sample period in order to calculate the beta coefficients for each listed commercial bank. Thus we compute 12 coefficients for each bank, that is, 12 x 9 = 108 coefficients.

4.3 Transparency index

In order to estimate a transparency index we apply an innovative approach based on the CAMELS risk assessments. We define the Transparency Index (BTI) as

$BTI = |(SCORE_1) - (SCORE_2)|$

---

[13] Contrary to this assumption, DeYoung *et al* (2001) show that the information contained in prudential reports is transferred to the market within short period of time and, particularly, "good" news is incorporated quickly whereas "bad" news with a time lag.

The idea is that if the disclosed risk assessment is similar to actual risk assessment, then the market participants can infer the riskiness from public disclosure and the difference between the two scores is small. Therefore, the difference between the two scores can serve as a good approximation for transparency, with a smaller number indicating more transparency.

In order for the above index to be robust, we must ensure that there is no transfer of information from confidential regulatory reports to the market participants. We run a test for detecting the validity of this constraint. The following regression is estimated for each bank

$$(SCORE_2)_i = a_1 + \gamma_1 (SCORE_1)_i + u_i \quad \forall i = 1...9$$

The residuals of the system represent the residual information set. If the two sets of information explain each other then the residuals are expected to exhibit no autocorrelation. If autocorrelation exists then there is no transmission of the regulatory information set to the market. The results are shown in Table 1 (see Appendix 3). Based on the Durbin-Watson statistic (DW), there is substantial autocorrelation in all equations, which provides support for our assumption of no transmission.

4.4 Hypothesis about the ability to monitor

From the theoretical model of transparency and the analysis of comparative statics the relationship between market risk assessment and actual risk assessment is positive, meaning that the market can effectively evaluate bank risk from public disclosure. In order to test the empirical validity of the hypothesis we run the following panel data regression

$$\beta_{1it} = a_{1i} + \gamma_1 BR_{it} + u_{1it} \quad \forall i = 1...9, \ \mathrm{t} = 1...12$$

where β_{1it} = the vector of beta coefficients for each bank $i = 1...9$, t = 1993…2004

$BR_{it} = \{SCORE_{1it}, C_{it}, A_{it}, M_{it}, E_{it}, L_{it}, S_{it}, combinations\}$

$SCORE_{1it}$ = the total score of CAMELS system ($SCORE_1$)

C_{it} = the score of the component "Capital"

A_{it} = the score of the component "Asset Quality"

$M_{it} =$ the score of the component "Management Effectiveness "

$E_{it} =$ the score of the component "Earnings"

$L_{it} =$ the score of the component "Liquidity"

$S_{it} =$ the score of the component "Sensitivity to market risk"

In the above system of equations we apply the fixed effects model. The constant term a_{1i} reflects all omitted variables with the additional assumptions that these variables are constant overtime but differ among banks[14]. Consequently the vector $a'_{1i} = [a_{11}, a_{12}, ..., a_{19}]$ should be estimated. It should also be mentioned that the vector γ_1 is constant for all the banks and its sign and statistical significance will indicate the validity of the hypothesis. In Table 2 (see Appendix 3) we present the results for two equations, one with the total score ($SCORE_1$) and a second with all individual components.

The coefficient of total score ($SCORE_1$) is positive, as predicted by the model, and statistically significant. This is an indication that the market can effectively monitor and analyse the bank risk. In order to evaluate the significance of the individual components of the CAMELS system, we run several regressions with each of the component or combinations of the components. The capital component (C) and the earnings component (E) turn out, in all cases, to be positive and statistically significant. These two components, either individually or in combination, provide the best estimated equations (not presented here), which further strengthen our argument for the ability to monitor. Regarding the other components, the strongest results are exhibited by the management component (M). However, in all cases it is negative, opposite to that predicted by the model.

4.5 Hypothesis about the ability to influence

From the theoretical model and the comparative statics analysis the relation between actual risk assessment and transparency is negative, implying that the market is not able to impose discipline, at least in the form of transparency. In order to test its

[14]Alternative we have estimated a time fixed effects model to capture time variability but the results were not significant and the model were not adopted.

validity we rely on the conclusion of section 4.4 where the ability to monitor has been empirically estimated. As a consequence beta and $SCORE_1$ can be used interchangeably and we run the following panel data regression:

$$BTI_{it} = \alpha_1 + \delta_1 \beta_{1it} + u_{1it} \quad \forall i = 1...9, \ \ t = 1...12$$

where β_{1it} = the vector of beta coefficients for each bank $i = 1...9$, t = 1993…2004

BTI_{it} = transparency index

The results are presented in the Table 3 (see Appendix 3).

The coefficient is positive and statistically significant implying that the market can force riskier banks to become more transparent. This conclusion is contrary to the results of theoretical model which predicted that riskier banks would be less transparent (more noise in their disclosure policy). This may be attributed to a possible mismatch between the concept of transparency used in the model and the one used in the empirical estimations. The theoretical model focuses on transparency, defined as the disclosed percentage of investment initiatives that are expected be successful, whereas the empirical specification may be broader and captures issues of corporate governance other than transparency.

5. Conclusions

The information gap between the banks and the market participants is widely acknowledged in the international banking bibliography. The sophistication of the market increases over time and thus the demand for new information on various aspects of bank activity. The banks cannot ignore the need for transparency but, being afraid of information property rights and of free riding by competitors, they are unwilling to satisfy completely the disclosure requirements of the market. We can usefully model this issue as a game between the banks and the market. We take advantage of this signaling game in order to develop a theoretical model of transparency. The model is used to develop two hypotheses about market discipline, that is, the ability to monitor the bank riskiness and the ability to influence the bank management actions. Then these hypotheses are empirically tested on Greek banking sector data. The results are somehow contradictory. The theoretical model predicts that market participants have the ability to monitor bank riskiness but they lack the ability to affect bank management actions in the form of transparency. The empirical application confirms the ability to monitor. However, contrary to the model prediction, it also confirms the ability to influence bank decisions.

To our knowledge, this is the first attempt to model the components of market discipline. The theoretical results of the model are not fully confirmed. Further work can be twofold. On the theoretical approach, a specification that captures more aspects of market participants' ability to influence as well as a multi-period model that incorporates the bank's opportunity to build a truth-telling reputation, may enhance the outcome of the model. One empirical approach, the application in more mature markets than the Greek banking sector, may provide better results. This may improve significantly the data sample but it has a drawback. This is the need for non-disclosed data, which may better capture bank risk, in order to calculate the transparency index.

References

Baumann U. and Nier E. (2004) “Disclosure, Volatility and Transparency: The Empirical Investigation into the Value of Bank Disclosure”, *FRBNY Economic Policy*, 31-45.

Berger N.A., Davies M.S., and Flannery J.M. (2000) “Comparing Market and Supervisory Assessments of Bank Performance: Who Knows What When?”, *Journal of Money, Credit and Banking*, 32 (3), 641-670.

B.I.S (2003) “Markets for Bank Subordinated Debt and Equity in Basel Committee Member Countries”, Basel Committee on Banking Supervision Working paper No.12.

Bliss R.R. (2004) “Market Discipline: Players, Processes and Purposes”, in C. Borio *et al* (eds.), *Market Discipline across Countries and Industries*, The MIT Press.

Bliss R.R. and Flannery J. M. (2002) “Market Discipline in Governance of U.S. Bank Holding Companies: Monitoring vs. Influencing”, *European Finance Review*, 6 (3), 361-395.

Blum J.M. (2002) “Subordinated Debt, Market Discipline, and Banks' Risk Taking”, *Journal of Banking and Finance*, 26 (7) 1427-1441.

Bongini P., Laeven L. and Majnoni G. (2002) “How Good is the Market at Assessing Bank Fragility? A Horse Race between Different Indicators”, *Journal of Banking and Finance*, 26, 1011-1028.

Boot A. and Schmeits A. (2000) “Market Discipline and Incentive Problems in Conglomerate Firms with Application to Banking”, *Journal of Financial Intermediation*, 9, 240-273.

Boot A. and Thakor A. (2001) “The Many Faces of Information Disclosure”, *Review of Financial Studies*, 14 (4), 1021-1057.

Caprio G. and Honohan P. (2004) “Can the Unsophisticated Market Provide Discipline?”, World Bank Policy Research Working Paper No. 3364.

Cordella T. and Yeyati E.L. (1998) “Public Disclosure and Bank Failures”, *IMF Staff Papers*, 45 (1), 110-131.

Crawford V. and Sobel J. (1982) “Strategic Information Transmission”, *Econometrica*, 50 (6), 1431-1451.

De Ceuster M.J.K. and Masschelein N. (2003) “Regulating Banks through Market Discipline: A Survey of the Issues”, *Journal of Economic Surveys*, 17 (5), 749-766.

DeYoung R., Flannery J.M., Lang W. W. and Sorescu M.S. (2001) “The Informational Advantage of Specialized Monitors: The Case of Bank Examiners”, *Journal of Money, Credit and Banking*, 33 (4), 900-925.

Gibbon R. (1992), *A Primer in Game Theory*, Harvester, Wheatsheaf.

Gropp R., Vesala J. and Vulpes G. (2002) "Equity and Debt Market Signals as Leading Indicators of Bank Fragility", ECB Working Paper Series No 150.

Healey P. and Palepu K. (2001) "Information Asymmetry, Corporate Disclosure, and the Capital Markets: A Review of the Empirical Disclosure Literature", *Journal of Accounting and Economics*, 31 (1-3), 405-440.

Herring R.J. (2004) "The Subordinated Debt Alternative to Basel II", *Journal of Financial Stability*, 1, 137-155.

Hyytinen A. and Takalo T. (2002) "Enhancing Bank Transparency: A Re-assessment", *European Finance Review*, 6, 429-445.

Hyytinen A. and Takalo T. (2004) "Preventing Systemic Crises through Bank Transparency", *Economic Notes*, 33 (2), 257-273.

Jordan J.S., Peek J. and Rosengren E.S. (2000) "The Market Reaction to the Disclosure of Supervisory Action: Implication for Bank Transparency", *Journal of Financial Intermediation*, 9, 298-319.

Jorion P. (2002) "How Informative are Value-at-Risk Disclosures", *The Accounting Review*, 77 (4), 911-931.

Kwan S. (2004) "Testing the Strong-Form of Market Discipline: The Effects of Public Market Signals on Bank Risk", Federal Reserve Bank of San Francisco Working Paper No. 2004-19.

Llewellyn D. (2005) "Inside the 'Black Box' of Market Discipline", *Institute of Economic Affaires*, 41-47.

Matutes C. and Vives X. (2000) "Imperfect Competition, Risk Taking, and Regulation in Banking", *European Economic Review*, 44, 1-34.

Morgan P. D. (2002) "Rating Banks: Risk and Uncertainty in an Opaque Industry", *American Economic Review*, 92, (4), 874-888.

Morgan P.D. and Stiroh K.J. (2001) "Market Discipline of Banks: The Asset Test", *Journal of Financial Services Research*, 20 (2-3), 195-208.

Nier E. and Baumann U. (2003) "Market Discipline, Disclosure and Moral Hazard in Banking" EFA 2003 Annual Conference Paper No. 664.

Rochet J.C. (2004) "Market Discipline in Banking", in C. Borio *et al* (eds.), *Market Discipline across Countries and Industries*, The MIT Press.

Shin H.S. (2003) "Disclosures and Asset Returns", *Econometrica*, 71 (1), 105-133.

Sironi A. (2003) "Testing for Market Discipline in the European Banking Industry: Evidence from Subordinated Debt Issues", *Journal of Money, Credit and Banking*, 35, 443-472.

Verrecchia R. (2001) "Essays on Disclosure", *Journal of Accounting and Economics*, 32, 97-180.

Wilson W., Rose L. and Pinfold J.F. (2004) "Market Discipline in New Zealand: Can Retail Depositors Exercise it?", Massey University Department of Commerce Working Paper No. 04-23.

APPENDIX 1

Component	Indicator
C	Capital adequacy ratio
A	Risk-weighted Assets /Total Assets
	Non-performing loans/Total loans
	Overdue loans /Total loans
	Provisions/Non-performing loans
	Supervisory provisions /Total loans
M	Operational Expenses/Total Assets
	Operational Expenses/Gross Profits
	Personnel Expenses/Total Assets
	Personnel Expenses/Gross Profits
	Interest rate spread
	Average cost per employee
	Average profit per employee
	Gross Profit per branch
E	ROA
	ROE
	Interest income /Total Assets
	Other Income /Total Assets
	Gross Profits/Total Assets
L	Liquidity index
S	Net outcome of 1% change on interest rates/ Regulatory capital
	Regulatory capital for FX risk/ Regulatory capital
	Regulatory capital for market risk/ Regulatory capital

APPENDIX 2

Component	Indicator
C	Own Funds/Total Assets
A	Provisions/Total loans
M	Operational Expenses/Total Assets
	Operational Expenses/Gross Profits
	Personnel Expenses/Total Assets
	Personnel Expenses/Gross Profits
E	ROA
	ROE
	Interest income /Total Assets
	Other Income /Total Assets
	Gross Profits/Total Assets
L	Liquid assets/Total Assets
	Liquid assets/Deposits
	Loans/Deposits
S	Equity portfolio/Total of Asset

APPENDIX 3

Table 1. Simple regressions: risk assessment comparison
Dependent variable $SCORE_2$

Variables	Bank 1	Bank 2	Bank 3	Bank 4	Bank 5	Bank 6	Bank 7	Bank 8	Bank 9
Constant	0.36 (0.07)	0.002 (0.01)	0.38 (0.05)	0.33 (0.02)	0.38 (0.04)	0.35 (0.03)	0.36 (0.04)	0.37 (0.04)	0.31 (0.07)
Independent variable $SCORE_1$	-0.04 (0.23)	1.07 (0.03)	-0.08 (0.15)	0.05 (0.06)	-0.08 (0.12)	0.04 (0.08)	-0.02 (0.12)	-0.06 (0.13)	0.12 (0.20)
R^2	0.00	0.98	0.02	0.06	0.04	0.02	0.00	0.02	0.03
DW	0.17	2.90	0.46	0.70	0.59	0.79	0.21	0.80	0.34

Notes: 1. Due to confidentiality of data the actual names of the banks are not disclosed

2. We have estimated the equation

$$(SCORE_2)_i = a_1 + \gamma_1 (SCORE_1)_i + u_i$$

with OLS for each bank $\forall i = 1 \ldots 9$.

3. The standard errors are shown in parentheses.

Table 2. Regression between bank risk assessment according to the market (β_1) and actual risk assessment as measured by CAMELS System		
Variables	Equation 1	Equation 2
SCORE 1	1.15 (0.50)	-
C	-	4.36 (1.36)
A	-	-0.96 (1.19)
M	-	-5.40 (1.34)
E	-	6.23 (2.43)
L	-	-0.23 (0.10)
S	-	-1.96 (2.63)
Fixed effects		
1	0.62 (0.18)	-3.60 (2.51)
2	0.20 (0.20)	-3.82 (2.49)
3	0.68 (0.18)	-3.42 (2.50)
4	0.18 (0.24)	-4.08 (2.50)
5	0.74 (0.18)	-3.37 (2.51)
6	0.71 (0.19)	-3.33 (2.52)
7	0.09 (0.22)	-4.08 (2.50)
8	0.63 (0.18)	-3.53 (2.50)
9	0.53 (0.18)	-3.70 (2.49)
R^2	0.35	0.52

Notes: 1. We have estimated the equations

$$\beta_{1it} = a_{1i} + \gamma_1 SCORE_{1it} + u_{1it} \quad \text{(Equation 1)}$$

$$\beta_{1it} = a_{1i} + \gamma_1 C_{it} + \gamma_2 A_{it} + \gamma_3 M_{it} + \gamma_4 E_{it} + \gamma_5 L_{it} + \gamma_6 S_{it} + u_{1it} \quad \text{(Equation 2)}$$

with SUR method and Weighted Least Squares respectively, for each bank $\forall i = 1...9, \ \ t = 1...12$.

2. The standard errors are shown in the parentheses.

Table 3. Regression of transparency index (*BTI)* on market assessment of bank riskiness	
Variables	Estimated coefficients
β_1	0.006 (0.002)
Fixed effects	
1	0.0085 (0.003)
2	0.024 (0.002)
3	0.014 (0.003)
4	0.025 (0.003)
5	0.016 (0.003)
6	0.014 (0.003)
7	0.020 (0.002)
8	0.015 (0.003)
9	0.013 (0.003)
R^2	0.25

Notes: 1. We have estimated the equation

$$BTI_{it} = \alpha_1 + \delta_1 \beta_{1it} + u_{1it}$$

with Least Squares, for each bank $\forall i = 1...9,\ \ t = 1...12$

2. The standard errors are shown in the parentheses.

BANK OF GREECE WORKING PAPERS

11. Papaspyrou, T., "EMU Strategies: Lessons from Past Experience in View of EU Enlargement", March 2004.

12. Dellas, H. and G. S. Tavlas, "Wage Rigidity and Monetary Union", April 2004.

13. Hondroyiannis, G. and S. Lazaretou, "Inflation Persistence During Periods of Structural Change: An Assessment Using Greek Data", June 2004.

14. Zonzilos, N., "Econometric Modelling at the Bank of Greece", June 2004.

15. Brissimis, S. N., D. A. Sideris and F. K. Voumvaki, "Testing Long-Run Purchasing Power Parity under Exchange Rate Targeting", July 2004.

16. Lazaretou, S., "The Drachma, Foreign Creditors and the International Monetary System: Tales of a Currency During the 19th and the Early 20th Century", August 2004.

17. Hondroyiannis G., S. Lolos and E. Papapetrou, "Financial Markets and Economic Growth in Greece, 1986-1999", September 2004.

18. Dellas, H. and G. S. Tavlas, "The Global Implications of Regional Exchange Rate Regimes", October 2004.

19. Sideris, D., "Testing for Long-run PPP in a System Context: Evidence for the US, Germany and Japan", November 2004.

20. Sideris, D. and N. Zonzilos, "The Greek Model of the European System of Central Banks Multi-Country Model", February 2005.

21. Kapopoulos, P. and S. Lazaretou, "Does Corporate Ownership Structure Matter for Economic Growth? A Cross - Country Analysis", March 2005.

22. Brissimis, S. N. and T. S. Kosma, "Market Power Innovative Activity and Exchange Rate Pass-Through", April 2005.

23. Christodoulopoulos, T. N. and I. Grigoratou, "Measuring Liquidity in the Greek Government Securities Market", May 2005.

24. Stoubos, G. and I. Tsikripis, "Regional Integration Challenges in South East Europe: Banking Sector Trends", June 2005.

25. Athanasoglou, P. P., S. N. Brissimis and M. D. Delis, "Bank-Specific, Industry-Specific and Macroeconomic Determinants of Bank Profitability", June 2005.

26. Stournaras, Y., "Aggregate Supply and Demand, the Real Exchange Rate and Oil Price Denomination", July 2005.

27. Angelopoulou, E., “The Comparative Performance of Q-Type and Dynamic Models of Firm Investment: Empirical Evidence from the UK”, September 2005.

28. Hondroyiannis, G., P.A.V.B. Swamy, G. S. Tavlas and M. Ulan, “Some Further Evidence on Exchange-Rate Volatility and Exports”, October 2005.

29. Papazoglou, C., “Real Exchange Rate Dynamics and Output Contraction under Transition”, November 2005.

30. Christodoulakis, G. A. and E. M. Mamatzakis, “The European Union GDP Forecast Rationality under Asymmetric Preferences”, December 2005.

31. Hall, S. G. and G. Hondroyiannis, “Measuring the Correlation of Shocks between the EU-15 and the New Member Countries”, January 2006.

32. Christodoulakis, G. A. and S. E. Satchell, “Exact Elliptical Distributions for Models of Conditionally Random Financial Volatility”, January 2006.

33. Gibson, H. D., N. T. Tsaveas and T. Vlassopoulos, “Capital Flows, Capital Account Liberalisation and the Mediterranean Countries”, February 2006.

34. Tavlas, G. S. and P. A. V. B. Swamy, “The New Keynesian Phillips Curve and Inflation Expectations: Re-specification and Interpretation”, March 2006.

35. Brissimis, S. N. and N. S. Magginas, “Monetary Policy Rules under Heterogeneous Inflation Expectations”, March 2006.